POWER

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ELY C. HUTCHINSON, *Editor*

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The Bullyragging Buyer

I WROTE last week of the attitude of superiority assumed by some buyers over those who come to solicit their patronage. There was another thought in the same connection which space limits did not permit me to include.

And that was with regard to the incredulous, antagonistic and even bullyragging attitude that some buyers habitually exercise toward those who seek to sell them anything.

Caveat emptor seems to be their motto, and they get behind a rampart of inapproachability and bustle with weapons of repulsion.

The first thing that a salesman expects from a buyer of this type is a sound berating for shortcomings, imagined or real, in past shipments or service, or alleged discriminations in price.

Woe to the salesman whose house has been derelict and given real cause of complaint. It will always be used in attempt to club him into a meek and pliable attitude, however unintentional it may have been or how thoroughly it may have been made good.

Some salesmen, by exaggerated claims for the superiority of their wares and stories of their wonderful accomplishments, invite expressions that indicate that their statements are not taken at their face value, but the mere fact that a man is being solicited to buy does not warrant him an open expression of distrust of and disrespect for the salesman.

I heard it remarked of the principal of a public utility that he got, with remarkable directness and clarity, out of those who called upon him the most and best that they could contribute in information and suggestion and then ended the interview.

The modern salesman knows things besides his price list and funny stories. There is no caste distinction between a buyer and a seller that warrants the scant courtesy with which the latter is treated by some small-sized individuals with whom he is compelled to deal.

EDITORIALS

Engineers View Their World

MAROONED in space on a spinning sphere eight thousand miles in diameter, man is physically dwarfed by the immensities that surround him. In the matter of size he is simply not worth bothering about. But, measured by the yardstick of intelligence, he becomes a real factor in the cosmic plan.

Already he has changed the face of the globe. Its surface is largely a pattern of his cities, villages, and farms, tied together by roads and steel rails. His ships plow the oceans on regular schedules. His messages pass from continent to continent over metallic strands on the ocean floor and through the air above. His factories—fed by mines, fields, and forests—pour out a never-ending stream of clothing, prepared foods, materials of construction, and machines that labor, transport, and record.

All of his activities are vitalized by the sun's stored energy, which, with uncanny skill, he abstracts from coal, oil, gas, and lifted water, and applies as heat, light, and mechanical muscle.

In the field of human relations, man's accomplishments, after an experience of hundreds of thousands of years, may have fallen far short of reasonable success, but the scientist and engineer may well take pride in the astounding success of their negotiations with natural forces over a period that is but a moment in the world's history.

THIS DEVELOPMENT could never have taken place if each country had been surrounded by a wall to stop the inflow of ideas. Herz in Germany and Marconi in Italy discovered the germ of radio. America now broadcasts to millions. Wright took a motor up in the air at Dayton. Today Europe's map as well as America's is a pattern of air lines.

Faraday played with conductors and magnets. On his foundation engineers of many countries developed dynamo-electric practice. And the whole civilized world of 1930 is netted with copper filaments carrying power, voice, light, and heat at lightning speed to innumerable points of use.

No need to multiply illustrations—it is clear that without international co-operation in the fields of pure science and engineering we should all be living back in the middle ages. But this co-operation, until reecntly, had been largely automatic. Men looked around and borrowed good ideas from any source. Today we have entered a new era of directed and accelerated co-operation in the field of engineering—particularly in all that concerns the generation, transmission, and application of energy. The World Power Conference, now in its second plenary session at Berlin, is its greatest example.

NEARLY FOUR HUNDRED papers, sponsored by the great national societies, summarize the best engineering thought of all nations. Among these are many contributions of outstanding merit—fundamental in treatment and data, economic in viewpoint and therefore practical in application.

The occasion is too important to let pass with a perfunctory report. *Power* devotes twelve pages in this number to an account of the first week's proceedings. A similar report next week will cover the concluding sessions. From these, and later abstracts of outstanding individual papers, American engineers at home may share in the productive thought of the greatest engineering conference ever held.

Elmer Ambrose Sperry

IN THE PASSING of Elmer A. Sperry, whose death occurred last week, the engineering world has lost one of its outstanding figures, one who never hesitated in exploring new fields of engineering application of physical laws. In fact, Mr. Sperry has for years been considered, by those who know the attainments of this most modest man, as the foremost of America's mechanical engineers.

One of Mr. Sperry's first attempts at invention was the design of an electric arc light, and he is credited with the construction of the first town lighting system in the country. Other inventions were a compound oil engine, beacon lights for aircraft, and the more spectacular mechanical helmsman and gyro-compass.

However, by its influence on engineering, his greatest invention was his last, the metal-flaw detector. This machine, while originally developed to detect flaws in railroad rails, has found its greatest usefulness in the discovery of interior pipes and flaws in steel casting and rolled steel shapes. Heretofore, the X ray was the only medium so used, but the expense made it prohibitive for all but the most vital work. The Sperry apparatus makes the inspection cheaply and instantaneously. It is the notable invention in metallurgy of the decade.

In spite of his admirable engineering ability, Mr. Sperry was best known, by those fortunate enough to come into contact with him, for his kindliness to the stranger, to the young engineer, and to the man of lowly position. Always he was ready to devote a few minutes of his valuable time to the visitor, no matter how trivial the mission.

• America has lost its foremost mechanical engineer, and the world a great advocate of engineering internationalism.

Prepare for the Emergency Before It Happens

OPERATING power equipment without proper protection has caused many disastrous wrecks, large property damage, and loss of life. Power-generating equipment has been wrecked by overspeed, with a heavy toll of life and property; but many plant owners are still willing to take a chance unless forced by law to provide protective apparatus.

Protection of equipment against emergencies is a form of insurance that no power-plant owner can afford to be without. The cost of protection is a few hundred dollars, compared to many thousands a wreck may cost. Worse than the damage to physical property and the interruption of operation is the loss of life that frequently results from such wrecks. Not only are engines wrecked, but all kinds of power equipment have failed in emergency when a few dollars invested in protective equipment would have prevented the catastrophe.

Even when protective equipment is provided it is frequently made inoperative, either intentionally or by neglect. Such "protection" is worse than none, as it may create a sense of security where none exists. Something that equipment will operate without, such as emergency protective apparatus, is likely to be neglected. A regular system of inspection and testing is the only way to insure its being in condition to function in an emergency.

The time to prepare for accidents is before they occur. If this important feature of plant operation is neglected until the unusual happens, the chances are largely in favor of nothing, or the wrong thing, being done to save the situation. Generally an emergency calls for quick thinking and action of the right kind, if damage is to be prevented. This is only acquired by giving attention to what may happen before it occurs.

"Ample Arteries" for Buildings

ARCHITECTS of great buildings are sensing the fundamental importance of the power services therein. They see that the skeleton of steel and the skin of brick and stone are useless unless steam, water, air, and electricity pulse dependably, and in ample quantity, through arteries of pipe, duct, and cable.

Only recently the architects of the new East River center for the New York Hospital announced that they had proceeded on the theory that the life of such a building is determined by its arteries. Many hospitals still of sound general construction, they declared, have become obsolete because of the inadequacy and inaccessibility of the arteries which carry their water, steam, electricity, and gas. They stated that in the New York Hospital all these lines are designed for double the immediate requirements, and that it will be possible when necessary to replace them and recondition the building to meet the changing needs of the future.

The architects of this great hospital group are to be commended for this far-sighted view. They have shown a way to decrease fixed charges by a slight increase in the investment. Postponement of obsolescence is their answer to the paradox.

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POWER *Stands for . .*

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

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Berlin

GREETS POWER

By ELY C. HUTCHINSON
Editor of POWER

President Von Hindenberg of the German Republic sponsored the Berlin meeting of the Conference

GROWN in six years to a position of far-reaching importance in international affairs, the World Power Conference convened June 16 for its second plenary session in Berlin, Germany. With more than 4,000 in attendance, it is the greatest engineering gathering of world-wide scope ever held. Not only are the leaders of engineering and science present, but the important figures of industry, finance, education, and government are there as well.

Economic in character, the central theme of the meeting bears mainly on problems of distribution and utilization of power. On this and closely related subjects over 400 papers have been contributed by engineers and economists of 47 nations—36 personally represented.

At a meeting of the International Executive Council on June 12, four days before the general sessions opened, O. C. Merrill, chairman of the American Committee, formally invited the conference to hold its third plenary meeting in the United States in 1936. The invitation was accepted.

On Sunday, June 15, a special gathering of 600 national chairman and other officers witnessed the inauguration of the new president of the conference, Oskar von Mueller, who succeeded Lord Derby. Receiving his insignia of office from Lord Derby, Dr. von Mueller responded, expressing appreciation of the great honor and reviewing his fifty years of experience in the electrical and hydraulic field. He said that Germany welcomed the opportunity to reveal its advancement in scientific institutions, in power resources, distribution networks, and factory reconstruction.

A reception in the evening by Drs. Koettgen, von Mueller, and Lord Derby, i nthe Reichstag Building, was preceded by an address in which von Kardoff, vice-president of the Reichstag, welcomed the delegates. Lord Derby reviewed the progress of power since the first plenary conference in 1924.

On Monday morning at the first general session, in a setting made brilliant by the flags of all nations, Presi-

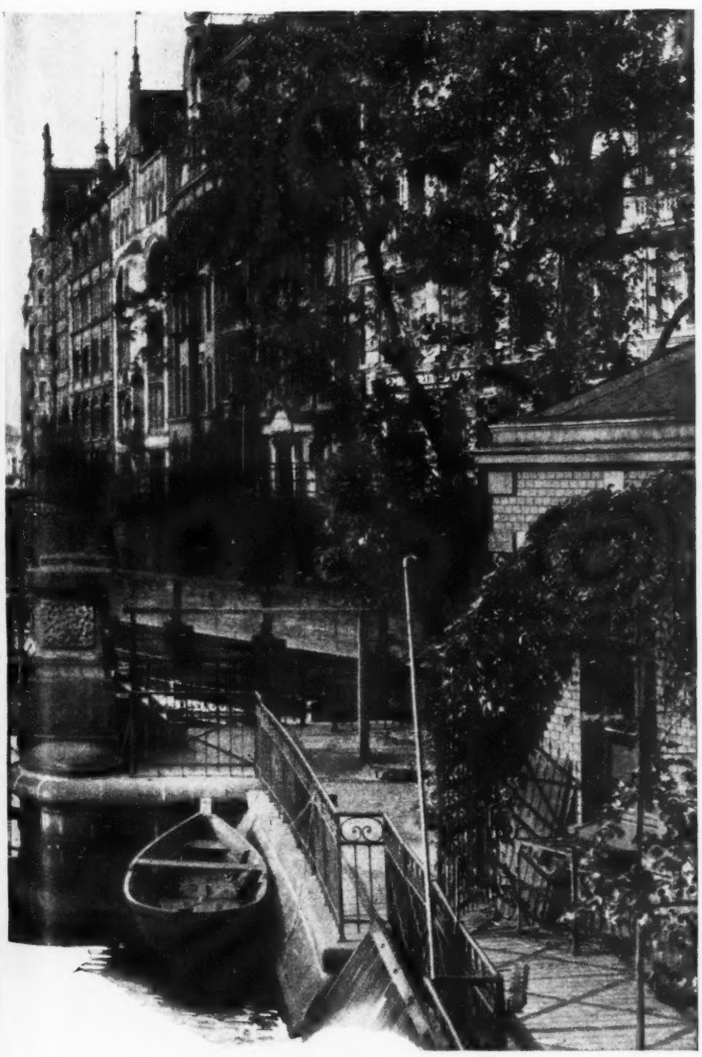
By Ewing Galloway, N. Y.

Where the River Spree cuts through Germany's Capital. In the distance is the "Dom" (Lutheran Cathedral)

Attending the World Power Conference as Editor of *Power*, and as an official representative of the U. S. Government, Mr. Hutchinson cables his impressions. The report will be concluded next week.

ENGINEERS of 36 Countries

dent von Mueller delivered the opening address of welcome. All stood while Chancellor Bruening read a message from President von Hindenberg. "Nothing," declared von Hindenberg, "is better calculated to league the nations of the world together than a mutual endeavor of this kind to further the common weal. . . . By developing the transmission of power, across political frontiers, engineering is about to exercise a greater influence on the economic life of peoples than ever before."



Following this representatives of various nations spoke briefly, the keynote of all their remarks being the recognized opportunity to utilize science not only as a force for better power economies but as an instrument to insure progress of mankind and lasting peace.

With unexpected clarity, Professor Albert Einstein expounded his new theory of the reality of space to the delegates at the afternoon session. Tracing the development of ideas about geometry and space, he said that space, birthplace of all matter and thought, has in the last few decades "swallowed up the ether and time and is about to swallow up the field and corpuscular theory, too, so that space will remain as the only theory representing reality." His new theory holds that space, having originated matter, now has turned around and is eating it up—"having its revenge."

In the evening the German Government gave a reception for the delegates in the Zoölogical Gardens, where O. C. Merrill, chairman of the American Committee, replied on behalf of the conference to the government's official welcome. Mr. Merrill pointed to the economic trend in engineering thought and extolled co-operation, particularly the international exchange of ideas. He closed with a toast to the German people.

Other general addresses during the week included those by Professor Surreys on the conception of rationalization prevailing in different countries, General Director Dr. Oliven on Europe's great power lines, and two in "The American Hour" on Wednesday afternoon.

In "The American Hour" Ambassador Sackett created much comment by directing attention to the spread between bus-bar cost of electricity and the price to retail domestic consumers. Particularly challenging was his statement, "I know of no other manufacturing industry where the sales price of the product to the great mass of consumers is fifteen times the actual cost of production of the article sold. My purpose is sharply to define a weakness that calls for the keenest thought in your deliberations.

"Until the power business is brought into line with other industries in the relationship of its cost of production to the price paid by the consumer there can be little justification for thinking that this great power industry is rapidly approaching perfection."

International Radio Hook-Up

Speaking in the same "American Hour" H. F. Bain, secretary of the American Institute of Mining and Metallurgical Engineers discussed the place of minerals in a power-sustained world. (See page 979 of this report.) An outstanding social feature was the official banquet on Wednesday evening at the Sports Palace, when the delegates listened to an exchange of messages by radio between the N.E.L.A. convention in San Francisco, celebrities in London and the conference in Berlin. (This broadcast is described more fully in the report of the N.E.L.A. convention, contained in this number.)

Besides the general addresses and social events, 25 technical sessions were held during the week. Papers of particular interest to readers of *Power* are abstracted in the following pages. The concluding report, to appear next week, will cover the remaining sessions. Long abstracts of certain papers will appear later.

Dr. Carl Koettgen, Chairman of the Conference

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CALIFORNIA

The history and problems of power development in the most completely electrified farm and home district in the world, namely California, was brought out in a thoroughly comprehensive paper by Prof. Robert Sibley, of Berkeley, Calif. Predicating his remarks upon a brief international survey of power production in which the combined kilowatt-hour output of the United States and Canada balance that of the rest of the world, the author outlined the engineering problems involved in the California development. Chief among these are the record-breaking distances, of 250 to 300 miles, over which, in some cases, it is necessary to transmit power at voltages up to 220,000, and an area only 20 per cent smaller than Germany. California's topography and isolation created not only physical difficulties, but also financial problems, the latter having been solved to a large extent by customer ownership of stock.

He showed how the solution of these problems has influenced the consumption of power in industry, agriculture and the home, the plentiful supply leading to new uses in the canning of fruit, on the farm, and in domestic application. As a result, the use of electricity in California is the highest per capita of any community of equal area.

The author reviewed many of the important developments in the state, and pointed out that, although for a number of years hydro power remained supreme, within the last few years, due to the availability of cheap oil and gas and to the increased efficiency of steam plants, the latter has become an important factor.

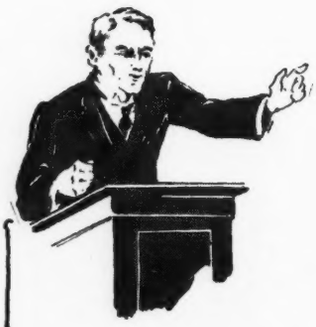
Professor Sibley commended the broad vision of the utility executives and also of the California Railroad Commission in the fixing of rates and encouraging of good public relations. In this the spirit of initiative and enterprise has found the fullest expression.

In view of the growing recognition of the importance of research, this subject was fittingly featured in one of the early technical sessions of the conference. Of particular interest in this session were papers on fuel investigations in Canada, researches on heat transmission and insulation in the United States and the investigation of windmills made by the Aero-Dynamic Institute at Moscow, Russia.

RESEARCH

An interesting result of Canadian studies, pointed out by B. F. Haanel in his paper, "Fuel investigations and research in Canada," is a changed attitude toward low-temperature carbonization. Formerly low-temperature distillation was not looked upon with favor by members of the staff of the Canadian Fuel Research Laboratories. However, recent tests carried out on Nova Scotia coal, using a well-known low-temperature carbonization process, have shown, he said, that a rather extensive field exists in certain portions of Canada for the introduction of some low-temperature process.

The report on "Researches on Heat Transmission and Insulation," in the United States, presented by W. V. A. Kemp, R. H.



LISTENING in THREE

GERMANY has applied the "automat" idea to language. To eliminate confusion of tongues, arrangements were made for each delegate to listen at will in English, French or German, regardless of the language used by the speaker. At each seat were a set of head phones and a "language switch." The speaker's words were translated without delay by interpreters whose microphones supplied the various language circuits. In addition the speaker's actual words were on tap through the same switch.

Heilman and Professors W. H. McAdams and H. C. Hottel, described the work being carried on by the Committee on Heat Tranmission, formed under the auspices of the Division of Engineering and Industrial Research of the National Research Council. This committee has 91 members, including scientists, engineers, and engineering executives. The main subjects considered by its sub-committee are:

(a) Heat transfer by convection.
(b) Thermal insulation.
(c) Definitions and nomenclature.
(d) Heat transfer by radiation.

The field of thermal insulation is so large that the subcommittee on this subject is further divided into groups dealing with high-temperature insulation, moderate-temperature insulation, building and low-temperature insulation, and electrical insulation.

WIND POWER

The efforts of the Central Aero-Dynamic Institute of Moscow have been concentrated on the investigation of wind energy, the investigation of wind wheels on a laboratory scale, and on the construction of new types of windmills, W. R. Ssektorow pointed out in his paper. In addition, a network of wind-measuring stations has been organized over the whole of Russia, while the institute has also put the former observations of meteorological stations on a systematic basis.

The institute, he said, has developed an original high-speed type of wheel, with self-regulating vanes, for windmills up to 8 meters wheel diameter, and is at present building a wind-power generating station in which the diameter of the windmill wheel is 30 meters (about 100 ft.).

STANDARD DIESEL OIL

In a session on "Rationalization Problems and the Standardization of Statistics," the paper by Capt. H. C. Dinger of the United States Navy outlined work being done by the A.S.M.E. on the standardization of Diesel oil specifications. He presented tentative specifications for heavy-duty engines and light high-speed engines.

Samples of fuel oil conforming to these requirements have been made up by various oil companies and sent to a number of manufacturers and users for try-out tests. Reports of results obtained are being received.

FUNDAMENTAL RESEARCH

"Research Relating to the Power Industry" was the subject of a paper by C. F. Hirshfeld, chief of research, the Detroit Edison Company. Research, Mr. Hirshfeld said, is defined as an ordered search for truth or the nearest approximation to truth which may, at the time, be available. It is a method of attack which may be applied to all human activities.

The results of research in pure science constitute the raw materials out of which industrial developments are made and on which further progress of our industrial civilization depends. The continuing support of research in the pure sciences is therefore necessary. It is a fact that research of this type has already dropped behind the requirements of the power industry in the sense that the latter cannot make further advances in some directions until the scientist can supply greatly needed information. This is particularly true with respect to the ultimate constitution or characteristics of matter and energy and the significance of such considerations in the improvement of dielectrics for various practical purposes.

He suggested that we are probably approaching the end of an epoch in power generation. This conclusion he based on the fact that we now appear to be able to calculate fairly accurately just what is possible in the future through the use of the methods of power generation now available.

EDUCATION

A highly illuminating interpretation of present educational trends in Germany was presented by Dr. Ing. C. Matschoss, director of the V.D.I., in a session devoted to "Education." After reviewing the early industrial history of Germany, Dr. Matschoss referred to the "eleven technischen hochschulen, which provide 22,000 students with the finest engineering training Germany has to offer." These technical universities are divided into large departments devoted to architecture, and civil, mechanical, electrical, mining, and chemical engineering. The great engineering associations, particularly the V.D.I. (German Engineer's Society), have long taken a close interest in these schools.

"It is a fundamental educational principle in Germany,"

LANGUAGES

Dr. Albert Einstein, Germany's greatest scientist, talked about space and matter

said Dr. Matschoss, "that no school can possibly turn out fully trained engineers. At least one year's practical work within the sphere of creative industry is necessary for the completion of the courses in engineering science at the technischen hochschulen."

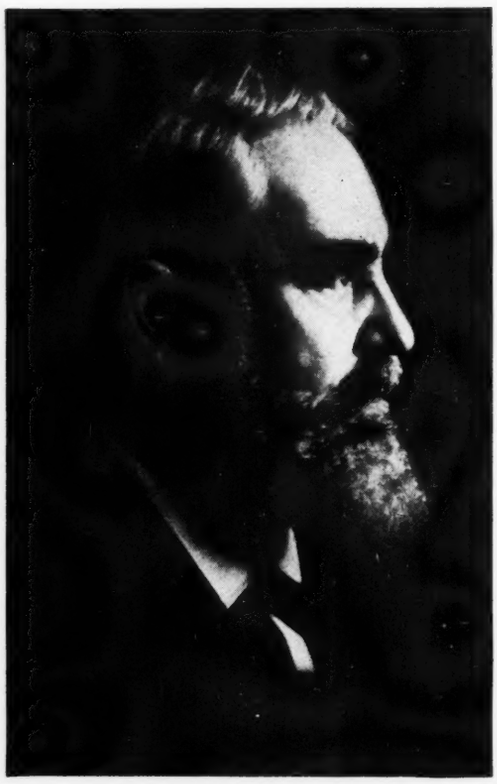
More important than specialization, in the opinion of German engineering educators, summarized by Dr. Matschoss, is sound training in the fundamentals.

They feel, he said, that teaching and research work should go hand in hand, since research work undoubtedly exerts a rejuvenating influence on teaching. Great stress, also, is laid on the importance of traveling, this object being promoted today by the exchange of students movements in all great industrial countries.

The present status of employee education in light and power companies in the United States was outlined in a paper by John P. Jackson. In this he showed that the electrical industry has from the start been a leader in educational activities.

The character of the educational opportunities made available to the employees are grouped as voluntary self-improvement, job training, supervisory training, and cadet courses.

"All large electric light and power companies in the United States," said Mr. Jackson, "have employees who voluntarily take educational courses. All of the companies give job training, and most of them have members who are at one time or another engaged in National Electric Light Association or other industrial or technical society activities of an educational nature. It is thus evident that training of employees is widespread throughout the industry and that few of them lack the opportunities for self-improvement. That, in large numbers, they not only receive compulsory training on the job, but engage in voluntary study, is indicated by the situation to be found in the group of companies in New York City. On Feb. 15 for this school year there was an enrollment of 13,168 employees in the formal company courses which are offered there for voluntary attendance. The aggregate enrollments in the courses of this group, since their establishment, have numbered slightly over 65,000."



Dr. Oskar von Mueller, president of the Deutches Museum, was chosen honorary president of the conference

MARINE POWER

In a session devoted to "Power Supply on Ships" a great future in the marine application of steam pressures above 300 lb. was predicted in a joint paper by the Hon. Sir Charles Parsons, R. J. Walker, and S. S. Cook.

"Apart from small historic installations which were in advance of their time and of the knowledge of the properties of steam," said the authors, "the first practical marine high-pressure installation was that of the T.S.S. King George V, a Clyde River steamer placed in service in 1926. Steam is generated at 550 lb. pressure in water-tube boilers and superheated to 750 deg. The steam is utilized in turbines to develop a power of 3,500 shaft-horsepower on two shafts, driven through gearing. This vessel in subsequent service showed considerable economy over others on the same routes.

The best and most efficient marine turbine unit so far evolved according to the authors, appears to be one consisting of three or more turbines grouped around a common gear wheel through which their power is transmitted to the shaft.

In a paper on the "Prospects of Pulverized-Coal Firing in Ships and the Development of Mechanical Stokers for Marine Use," Engineer Rear Admiral W. M. Whayman of the British Navy presented data to show that both these methods of firing, properly installed and handled, show a definite commercial saving over handfiring. He reviewed operating results obtained with several American pulverized-fuel installations. "Development of mechanical firing of coal," he said, "is of particular importance to Great Britain, because of her great coal fields and lack of petroleum resources."

Discussing "The Present Position of the Heavy Marine Oil Engine Industry in Great Britain," Prof. A. L. Mellanby said that Great Britain occupies a pre-eminent position in motorships. Lloyds Register of shipping (for the world) shows that in 1914 the number of motorships was 297, of a gross tonnage of 234,287. In 1929 the number of vessels had risen to 3,246 and the tonnage to 6,628,102. Of the new vessels to which classes have been assigned by Lloyd's committee during the past year, there are 159 motorships totalling 785,921 tons. Out of these, 71 vessels of 339,976 tons have been built in the United Kingdom. At the time at which his paper was written, said Prof. Mellanby, 101 motorships of a gross tonnage of 651,975 were being built in Great Britain and Ireland.

Speaking of the Scott-Still engine, which utilizes waste heat from the oil-engine cycle to generate steam for further power production, he mentioned two vessels so powered, the Dolius and the Eurybates. Each of these vessels is fitted with combined oil and steam engines, the oil-engine side working on the two-stroke-cycle principle with port exhausting and scavenging. The Dolius has two four-cylinder engines, designed to develop a total of 2,500 b.hp. at 120 r.p.m. Steam generated from waste heat is used on the underside of the combustion cylinder pistons. The exhaust steam from both engines passes to a turbo-blower which supplies the scavenge air to the combustion cylinders.

The engines of the Dolius were exhaustively tested on the test bed and at sea in 1924. As an illustration of the manner in which her machinery has maintained its high efficiency, Professor Mellanby pointed to the fact that in a recent run from Liverpool to Port Said she maintained an average speed of 11.53 knots when displacing 11,100 tons, with a fuel consumption of 8.67 tons per day, or 0.363 pounds per brake horsepower-hour.

GAS FUEL

Gustav Egloff presented a paper on "Hydrocarbon Gas as Power in the United States." A brief abstract follows:

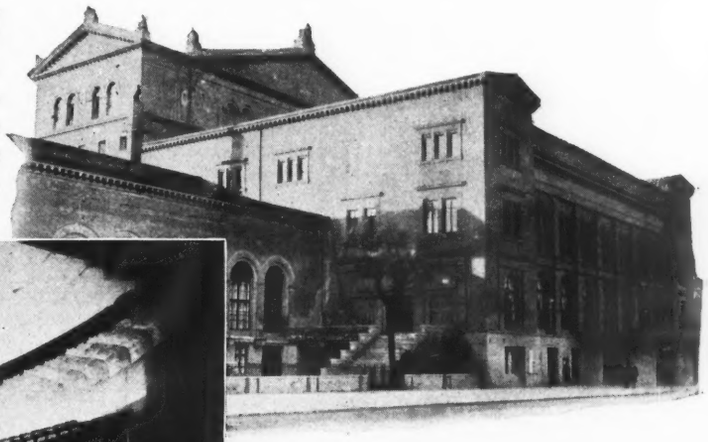
A change in fuel practice of great moment occurring in the United States is the increasing use of gas. This increase is particularly in natural gas, gas from petroleum distillation, and gas from the cracking process. The combined volume of these three gases produced in 1929 was 2,320,000,000,000 cu.ft., valued at $500,000,000 and equivalent in fuel value to more than one-sixth of the coal mined in the United States.

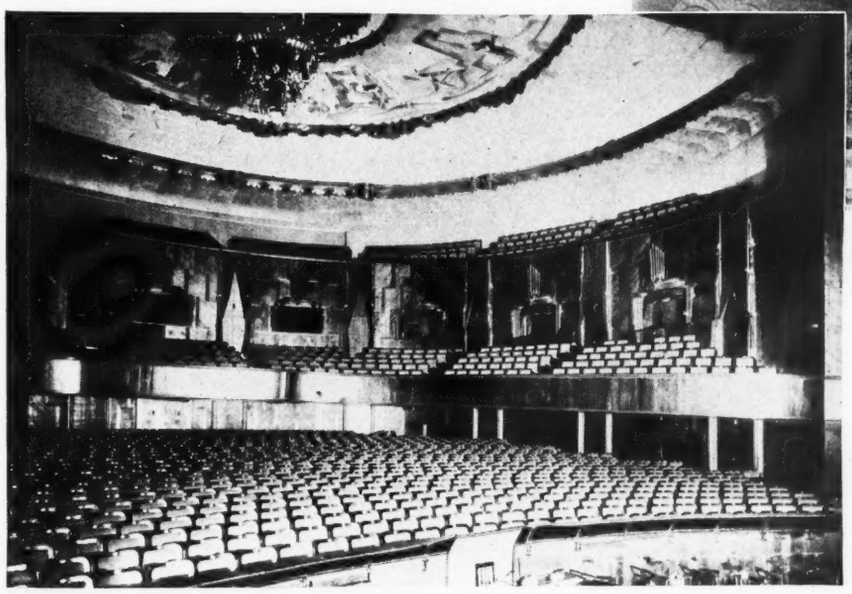
Three-quarters of this volume was natural gas. Natural gas is produced in every oil field, and many times occurs where oil is not present.

Among the industries, some of the largest users of natural gas are electric generating plants, petroleum refineries, ceramic and glass factories, steel mills, and smelters.

The cracking process and the distillation of petroleum together furnish as much gas as is manufactured in all the city gas plants in the United States. Much of the gas from the petroleum industry serves as refinery fuel, but in increasing amount it is finding employment in the enriching of gas of lower calorific value, and as raw material for chemical synthesis.

The increased use of gas means cleaner cities, a lessening of expenditures for removing dirt, and a healthier city population. To producers of coal the expansion of gas consumption may seem a menace, but to a forward-looking coal industry the situation in reality offers enlarged opportunities. Coal should be carbonized at the mines, to furnish gas, oil, and coke; the oil should be cracked to gas, gasoline and coke, and the coke gasified. The two products, gas and gasoline, would be piped to consuming centers.





The Kroll Opera House in Berlin, scene of the Second World Power Conference. At the left is the auditorium. Technical sessions are being conducted, three at a time, in various reception halls of this building

U. S. A. POWER COSTS

An important feature of the conference was an international power inventory in the form of a session devoted to "Individual Problems of Power Supply in Different Countries."

A summary of cost data on ten representative large power stations in the United States with ratings ranging from 100,000 to 300,000 kva., was presented by L. W. W. Morrow, editor of *Electrical World*. Fuel (per kilowatt hour), in these stations, ranged from 0.142 to 0.418 c., and total operating costs from 0.188 to 0.489 c. Wages and supplies ranged from 0.031 to 0.076 c. Maintenance costs (not included in operation) ranged from 0.018 to 0.06 c., and total fixed charges (on a 15 per cent basis) from 0.341 to 0.768 c. Total production charges ran from 0.216 to 0.549 c., and the total cost of a kilowatt-hour at the station feeder from 0.656 to 1.317 cents.

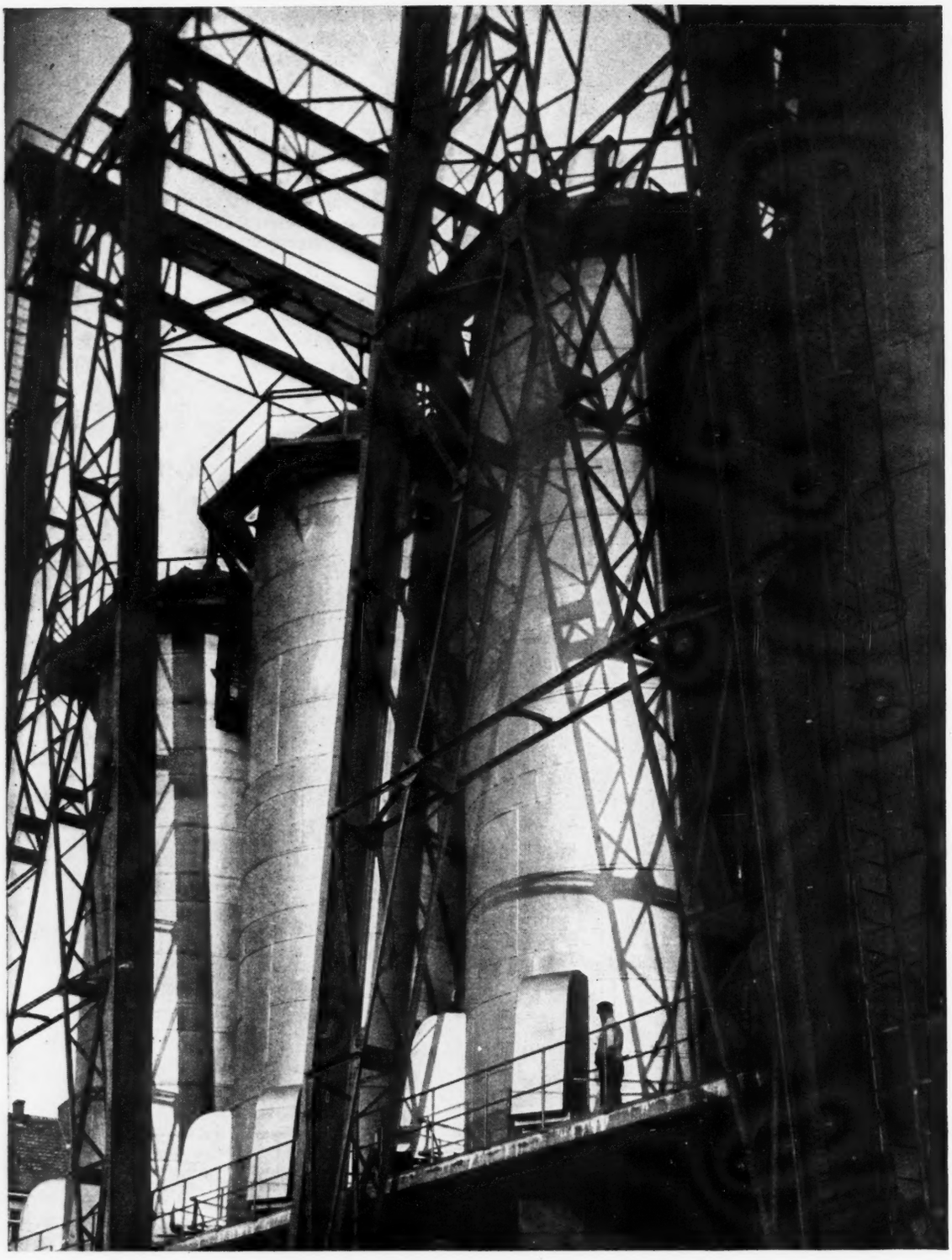
A paper on "Generation, Transmission and Distribution of Electricity in Canada," by J. C. Smith and Prof. C. V. Christie, estimated the present available water power in Canada as around 33,000,000 hp. Total capital invested there in water-power development, including transmission and distribution, is $1,172,600,000, an average of $219 per horsepower installed. Of this, $152, or 69.5 per cent, is in generation.

RUSSIA'S FIVE YEAR PLAN

In view of the general interest in the working out of Russia's much-discussed Five-Year Plan of industrial development, there has been a demand for information on the power features of this plan. The rate at which the necessary power facilities can be developed will admittedly be a limiting factor in the general economic development.

The progress already made in power development in Russia is noteworthy, according to statements made by S. A. Koukel-Krajevsky in his paper on the "Five-Year Plan of Electrification in the U.S.R.R."

Including factory plants, the yearly output in billions of kilowatt-hours has increased, he declared, from 1.9 in 1913 to 5.2 in 1927-28. The plan calls for 26.0 in 1932-33. Installed capacity, including factory plants, in-



One end of the battery of steam accumulators (the world's largest) at the Berlin Municipal Electricity Works in Charlottenburg. In this battery are sixteen tanks, each having a volume of 11,000 cu.ft. The total steam storage capacity is one million three hundred pounds, sufficient to generate 67,000 kw.-hr.

creased from 1.0 million kilowatts in 1913 to 1.87 in 1928. The plans call for 7.7 in 1933. It will be noted that energy output has increased far faster than installed capacity, due largely, according to Mr. Koukel-Krajevsky, to the scheme of continuous operation of all industry (five-day week with staggered holidays).

It was pointed out in the paper that the Soviet system has blotted out all distinction between utility and private plants. The sources of fuel for and the distribution of energy from each plant are specified by the government in the interests of national economy. Many industrial plants exchange power with the distribution systems.

MINERALS AND POWER

An extract from Ambassador Sackett's address in the "American hour," on June 18, has already been given (page 773). At the same meeting H. F. Bain, secretary, American Institute of Mining and Metallurgical Engineers, spoke on the "Place of Minerals in a Power-Sustained World."

"Power, mechanically produced, now rules the world," said Mr. Bain. "It is the agency through which the peoples of western Europe and America largely dominate world affairs. The greater aggregate population of Africa, Asia, and eastern Europe weigh but lightly in the world's scales, because they depend largely on their own efforts and utilize but little the forces of nature to supplement human labor. It is power that lengthens and strengthens the arm of man to do his will around the world; that enables him to see and to hear at distances far beyond the reach of human eye or ear; that heaps at his feet the products of the whole globe; that, in fact, converts life from a struggle against nature for existence, into an opportunity for continuous development and enjoyment under conditions of security and comfort. It is power, and its wide use, that binds the modern world together and makes modern civilization itself possible; but back of power stand always the minerals which are necessary to it."

TURBINE OPERATION

In a session on the "Construction and operation of large power plants," Dr. A. Peucker, of Germany, pointed to a possible saving in station operation. He felt that starting of units might be speeded to the point where it would be unnecessary to keep spare units turning over for emergency use. The ultimate limit of starting speed, he stated, is represented by the time required to accelerate the moving parts of the turbine from rest to normal revolutions per minute. This may be as little as 10 or 15 sec. Actually, of course, the heating up of the unit is the main limiting factor.

Dr. Peucker said that the total masses required to be heated should be as small as possible, and the design such as to reduce temperature deformation. Fixed points and bearings must be so located that an increase in heat and pressure will cause both the casing and the rotor to expand in the same direction.

The author stated that by proper design of a unit, by a trained operating staff, and by a layout using a minimum number of cutoff valves, starting time might be reduced substantially from the 25 to 30 min. now required for a good machine of medium size.

SMOKE

In a critical analysis of American progress in smoke abatement, V. J. Azbe analyzed the causes of the general failure in this country to solve the problem for whole communities. He felt that there has been too much compromising. "The aim," he said, "should be toward complete elimination, and requirements should be set up rigid enough to make this possible, and then they should be strictly enforced."

He suggested specifically that "only comparatively foolproof furnaces and devices that are completely smokeless, or nearly so, even in the hands of a careless person, should be allowed, and the firing of these furnaces must be simple."

"The up-draft principle of firing coal," declared Mr. Azbe, "is permissible only when the coal is fed to the furnace continuously in small quantities by automatic means. The larger users of boilers in industrial establishments should be required by law to use approved automatic stokers, preferably of the chain-grate or some underfeed type. Hand-firing should be forbidden. Boilers used for heating purposes in large buildings should be equipped with automatic underfeeding devices."

PLANNING POWER SYSTEMS

In his paper, "Planning Power System Development," E. C. Stone stressed the importance of the "master plan." Its usefulness, he pointed out, lies chiefly in its general principles rather than in details. "Long-range forecasts of the future are never accurate, and it is inevitable that conditions that actually develop will necessitate frequent changes in the details of the plan.

"Development of the master plan is a continuing process, the principles established are based on the state of the art at the time they are set up. As the art advances, and new lines of equipment are developed, it becomes desirable to set up new principles."

RESERVE STEAM TURBINES

A plan whereby a non-operating turbine-generator can be made to function as an immediately available power reserve was presented in a paper by E. Brown for the Swiss National Committee.

The method consists in applying auxiliary heat to the turbine, or at least to its high-pressure parts, during the period of its non-operation. Thus the surfaces to be suddenly exposed to the full flow of working steam are maintained at temperatures substantially equal to, or higher than, the saturation temperature of the steam.

Of the several methods of applying this heat, preference is given to the use of electrical resistances; first, because the temperatures available are unlimited, and, secondly, because their installation is convenient and inexpensive. Preference is further given to the distribution of this heat over the absorbing surface by utilizing the air inclosed by the lagging as a heat carrier, for which purpose it is circulated by a fan.

The suppression of superimposed heat stresses during starting and taking load permits of the use of higher temperatures and pressures, and in consequence improves the thermodynamic efficiency.

Incidentally, Mr. Brown pointed out, preheating the turbine in this way eliminates the condensation that ordinarily forms when steam enters a cold machine.

GENERATORS

The economic limit to the rating of large waterwheel - driven generators was discussed in a paper by F. D. Newbury and M. W. Smith (National Electrical Manufacturers Association). The session covered "Construction of Large Generators and Transformers."

After considering the limitations imposed by stresses,

flywheel effect, overspeed, line-charging capacity, stability, voltage variation, etc., comments of particular interest were made on temperature losses and ventilation. "Until recent years," said the authors, "temperature was one of the greatest limitations in waterwheel generator design. This condition no longer exists, due to improvements which have been made in ventilation and loss prevention."

"With improvements in ventilation, this question naturally arises: 'Why not reduce the size of machine, and hence increase the losses until temperature again becomes the limit of design?' The answer is found in the economic analysis of the problem. The saving in cost is not equal to the capitalized value of the increase in losses.

"One important present-day tendency in water-wheel generator design and application is the greater attention given to the economic importance of low losses. The value of low losses in steam-driven generators, transformers, and condensers is obvious. In earlier hydro-electric developments, where usually a site or a river was only partly developed, high losses meant little more than passing more water through the turbine. They did not represent any increase in operating cost or loss of output. However, in most large projects of the present time the hydraulic development contemplates storage and use of all available water (except during abnormal flood periods); so that it is logical to consider the generator losses as loss of possible output and revenue, or an additional load that must be supplied by steam stations. Since the major cost element of hydro-electric power is interest and depreciation on first cost, any reduction in useful output results in an almost proportional increase in cost per kilowatt-hour.

"These considerations have led to the general practice of evaluating generator losses at the appropriate investment value, and so determining the best general efficiency for a particular application. Values employed may vary from $100 to $250 per kilowatt. Application of these principles to generator design has resulted in a demand for lower losses, until large generators now have full load efficiencies of 97 to 98½ per cent."

The authors also pointed out that the use of fabricated construction in waterwheel generators has increased rapidly in recent years, and has had a marked influence on mechanical design.

STEAM TURBINES

That the present maximum capacity of 160,000 kw. in a single steam-turbine shaft will be exceeded in the future, was the prediction made by M. A. Savage in his paper "Economic Developments in Turbine Generators in the United States." The development of such units will, however, require even better materials than those now used. "For each increase of 10 per cent in diameter," he said, "an increase of approximately 33 per cent is secured in the rating of such machines.

"The demand for a large machine," the author stated, "arose from the combining of large power systems in America into the still larger super-power systems. Formerly an individual generator was installed as part of a rather isolated system, and its size was dictated largely by the percentage of connected load. Large machines, he pointed out, not only reduce the generator cost per kilowatt but also the cost of switch gear and other accessories.

"In meeting the demand for generators in present sizes the manufacturer is dependent to a large extent on the cost of raw materials in sizes and quantities sufficient to meet the demand, and, finally, upon the transportation to get the finished article to its destination. The latter limitation has called for considerable ingenuity on the part of the designers and manufacturers."

Mr. Savage predicted that the general adoption of hydrogen cooling would be the next step forward in the increased efficiency of large units.

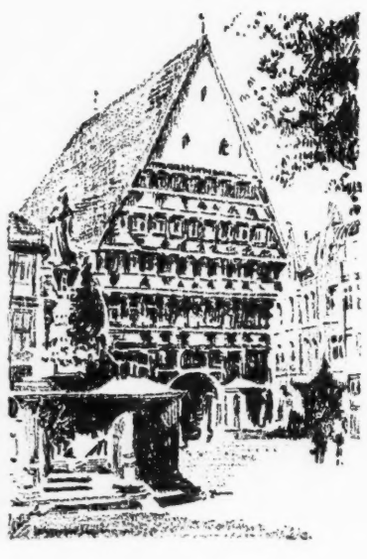
In a session devoted to "Natural and Synthetic Oils," H. C. Dickinson, of the United States Bureau of Standards, outlined the situation of volatile fuels in the United States and predicted that it would be some years before such fuels obtained from the distillation of oil shales and the distillation of coal could compete with hydrocarbons now obtained from crude oil and natural gas.

STEAM AND HYDRO

The predominant position of hydro-electric power in the electrical energy production of Italy was made clear by Ing. E. Cesari in the session devoted to "Co-operation of Different Power-Producing Plants." He pointed out that, in 1928, 98 per cent of all the energy produced came from water power. A great many steam plants (mostly erected between 1895 and 1915), of small installed capacity and of antiquated design, are gradually being taken out of service and, in many cases, being dismantled. A few remain in operation as local reserve plants. The factors working against steam power production in Italy, as pointed out in the paper, are the small reserves of coal and liquid fuel and the economic and political reasons that make it necessary for Italy to render herself, as far as possible, independent of fuel.

The water-power resources of Italy, as listed in the paper, may be considered well up to the average. The country has many mountain regions with good rainfall.

However, Mr. Cesari said, the best situations have already been made use of and, as, little by little, the erection of new hydraulic plants is proceeded with, they become more costly and difficult. This makes it necessary to utilize, to an even greater extent, the hydraulic resources that have already been exploited. It involves the regulation of flow by storage reservoirs, the interconnection of various districts and various stations, and, finally, provision of steam power stations.



"It appears," said the author, "that steam power must be applied to an increasing extent in the future. A recent tendency has been for groups of industrial plants to locate at a seaport, where fuel is cheapest, and to obtain power and steam from a single group plant. Some of these plants use coal and some oil. There are six such stations, the steam pressures ranging from 350 to 500 lb. and the temperatures ranging from 700 to 800 deg. F. The capacity of individual units ranges from 10,000 to

30,000 kilowatts. "In view of the duties which they are called upon to perform," said the author in the conclusion of his paper, "it is unlikely that any super-power stations will be erected."

The plants referred to by Mr. Cesari are situated in Genoa, Turbigo, Piavenza, Venice, Leghorn, and Naples.

"Economics of Combined Hydro and Steam Power Stations," a paper by N. E. Funk (U.S.A.) showed that the interconnection of power systems has totally changed the situation in respect to hydro-electric power generation. In general, the use of hydro power involves long transmission lines and relay steam generating stations, at the load centers, that can immediately supply the most important part of the load in case of transmission line trouble.

"The continued increase in the size of steam-electric generating units," said Mr. Funk, "has brought with it increased periods of time required for starting from a cold condition. This necessitates continually operating more capacity than would otherwise be necessary to be prepared for emergencies. The hydro-electric power station is an ideal supplement to these large steam-electric units, because starting-up time of the hydraulic turbines is short, thus permitting of a reduction in the amount of steam-electric generating capacity that must be kept in operation for service insurance. This lowers the operating cost of steam stations and of the system."

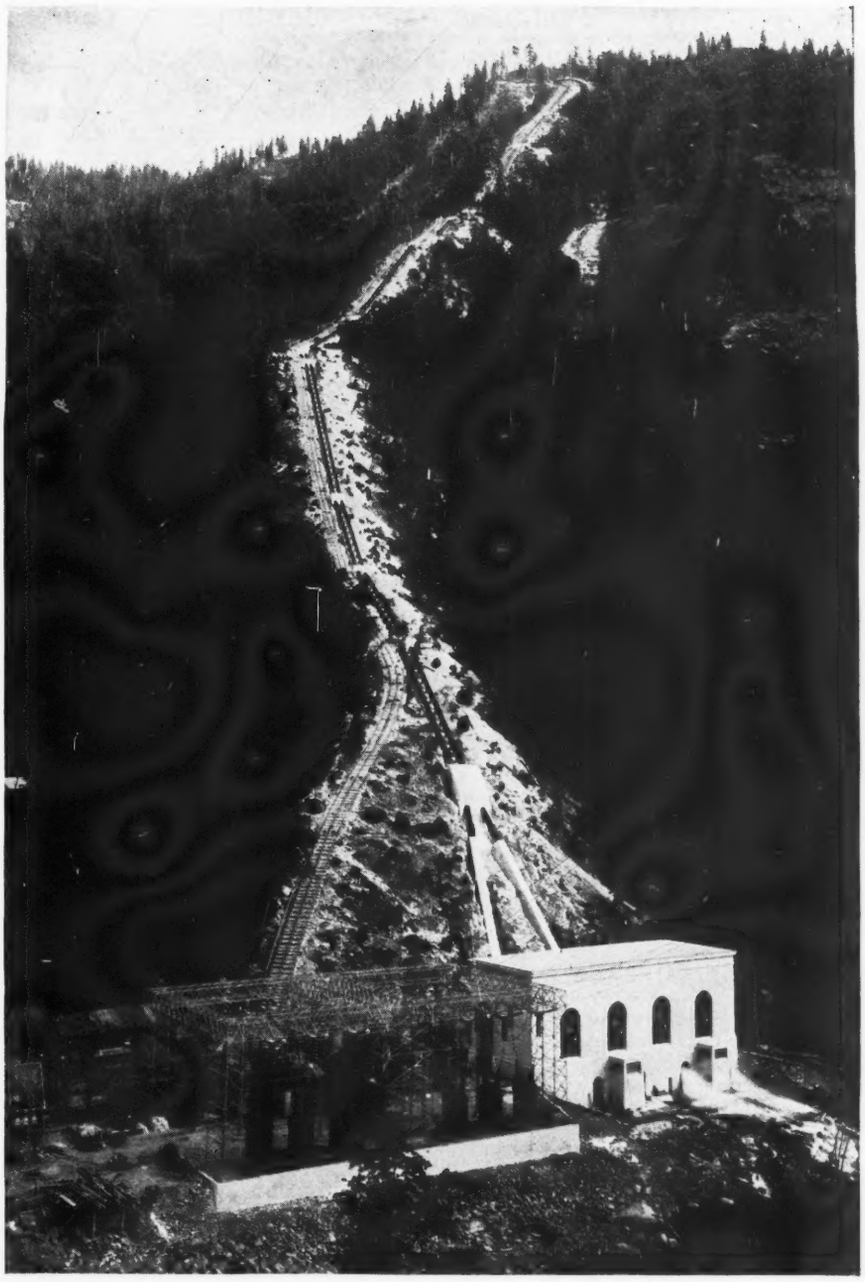
Mr. Funk pointed out that, where the source of hydro-electric power is a stream having great variations in flow and sufficient storage to equalize flow for short periods, the hydro station should be operated as a base-flow plant during periods of high stream flow, at which time the steam-electric plants will supply the peak load. Conversely, when steam flow has fallen to a low value, the capacity of a hydro-electric plant will be very seriously reduced if operated as a base-load plant, and it should then carry the peak.

[An abstract of Mr. Funk's paper will appear in an early number of *Power*.]

Problems involved in the regulation of prime movers in parallel-connected power stations, particularly where the plants are used for traction work, were discussed in a paper by Dr. Techn. A. Hruschka and Ing. H. Schmidt, of Austria.

They submitted a graphical method for calculating the safe active output of each station.

Closing the first week of a highly productive conference, two sessions held on the morning of Saturday, June 21, dealt respectively with "The transmission and flow of energy in single and multiple-connecting networks," and "Stationary internal-combustion engines and research work in this field."



Buck Creek development, the highest head plant on U. S. Pacific Coast (From paper by Robert Sibley)

BRITISH "GRID"

In the session on transmission Sir Archibald Page and C. W. Marshall of Great Britain presented a paper, "The British Grid System and Its Relation to Certain Technical and Economic Problems." The British "grid," as explained in the paper, is a national network of transmission lines measuring approximately 3,000 miles and interconnecting the principal generating stations.

The purpose of the grid, according to the authors, is to put the production side of the electricity supply industry on a basis which will insure minimum costs and increase availability of supply. The grid is not intended for the transmission of large blocks of energy over long distances. Coal is obtainable at a more or less uniform

Technical Papers Mentioned in This Week's Report

(Arranged in order of sessions. General addresses, including remarks of von Hindenburg, von Mueller, Einstein, Ambassador Sackett, O. C. Merrill, H. F. Bain, etc., are mentioned on pages 972 and 973.)

PROF. ROBERT SIBLEY (N.E.L.A., U.S.A.)—*"Power Developments in California"* (page 974).

Section 32—Research Work

B. F. HAANEL (Canadian Management Committee)—*"Fuels Investigations and Research in Canada"* (page 974).

W. V. A. KEMP, R. H. HEILMAN and PROFESSORS W. H. McADAMS and H. C. HOTTEL (National Research Council; American Society of Heating and Ventilating Engineers; U.S.A.) (page 974).

W. R. SSEKTOROW (Central Aero-hydrodynamic Institute; Russia)—*"The Work of the Z.A.H.I. on the Utilization of Wind Energy in the U.S.S.R.* (page 975).

Section 23—World Problems of Power Supply

C. F. HIRSHFELD (N.E.L.A., U.S.A.)—*"Research Relating to the Power Industry"* (page 975).

Section 33—Standardization Problems

CAPT. H. C. DINGER (A.S.M.E.; U.S.A.)—*"Standardization of Requirements for Diesel Fuel"* (page 975).

Section 34—Education

DR. ING. C. MATSCHOSS (V.D.I.; Germany)—*"Technical Education in Germany"* (page 975).

JOHN P. JACKSON (N.E.L.A.; U.S.A.)—*"The Present Status of Employee Education in Light and Power Companies in the United States"* (page 976).

Section 27—Power Supply on Ships

HON. SIR CHARLES PARSONS, R. J. WALKER and S. S. COOK (British National Committee)—*"Further Developments in the Application of High-Pressure Steam to Navigation"* (page 976).

ENG. REAR-ADMIRAL W. M. WHAYMAN (British National Committee)—*"Prospects of Pulverized Coal Firing in Ships and Development of Mechanical Stokers in Ships"* (page 976).

PROF. A. L. MELLANBY, D.Sc. (British Marine Oil Engine Manufacturers' Association)—*"The Present Position of the Heavy Marine Oil-Engine Industry in Great Britain"* (page 976).

Section 5—Gas Markets

GUSTAV EGLOFF (U.S.A.)—*"Hydro-Carbon Gas as Power in the United States"* (page 977).

Section 22—Individual Problems of Power Supply in Different Countries

L. W. W. MORROW (N.E.L.A.; U.S.A.)—*"Power Costs and Trends in the U.S.A."* (page 977).

C. SMITH and PROF. C. V. CHRISTIE (Canadian Management Committee; Canada)—*"Generation, Transmission and Distribution of Electricity in Canada"* (page 977).

ING. S. A. KUKEL-KRAJEWSKI (Central Electrotechnical Council; Russia)—*"Five-Year Plan of Electrification in the U.S.S.R."* (page 977).

Section 7—Construction and Operation of Large Power Plants

DR. A. PEUCKER (V.D.I.; Germany)—*"Influence of Readiness for Operation Through Construction and Size of Steam Turbines in Generating Stations"* (page 979).

VICTOR J. AZBE (American Committee)—*"A Critical Analysis of American Progress in Smoke Abatement Work"* (page 979).

E. C. STONE (N.E.L.A.; U.S.A.)—*"Planning Power System Development"* (page 979).

E. BROWN (Swiss National Committee)—*"The Idle Turbo Generator as a Momentary Reserve"* (page 979).

Section 18—Construction of Large Generators

F. D. NEWBURY and M. W. SMITH (N.E.M.A.; U.S.A.)—*"Economic Limits to the Rating of Large Water Wheel Driven Generators"* (page 979).

M. A. SAVAGE (N.E.M.A.; U.S.A.)—*"Economic Developments in Turbine Generators in the U. S."* (page 980).

Section 28—Production of Natural and Synthetic Oils, Their Treatment and Properties

H. C. DICKINSON (Bureau of Standards; U.S.A.)—*"Volatile Liquid Fuels"* (page 980).

Section 17—Co-operation of Different Power Producing Plants

ING. E. CESARI (Engineering Committee; Italy)—*"The Great Power Stations of Italy"* (page 980).

N. E. FUNK (N.E.L.A.; U.S.A.)—*"Economics of Combined Hydro and Steam Power Systems* (page 981).

Section 26—Steam and Electrically-Operated Railways

DR. A. HRUSCHKA and ING. H. SCHMIDT (Austrian National Committee)—*"Load Division Between Railways Operating in Parallel"* (page 981).

Section 20—The Flow of Energy in Single and Multiple-Connected Networks

SIR ARCHIBALD PAGE and C. W. MARSHALL (Central Electricity Board; Great Britain)—*"The British Grid System and Its Relation to Certain Technical and Economic Problems"* (page 981).

Section 29—Internal Combustion Engines

M. GERCKE and DR. ING. A. BANNWARTH (Union of Central Stations; Germany)—*"Newest Developments of the Diesel Engine with Particular Reference to Its Application to Peak Load Operation"* (page 982).

A. L. BIRD (British Marine Oil Engine Manufacturers' Association)—*"Some Characteristics of Nozzles and Sprays for Oil Engines"* (page 983).

A. E. L. CHORLTON (British National Committee)—*"The Heavy Oil Engine: Notes on the Position of Research in Great Britain"* (page 983).

DR. F. MERKL (Austrian National Committee)—*"Combination Internal Combustion and Steam Engines"* (page 983).

J. KUTTNER (A.S.M.E.; U.S.A.)—*"Development of the Stationary Diesel Engine Under the Conditions of American Power Economics"* (page 983).

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price in the vicinity of all the load centers, and there is little available water power. Consequently, most of the power used is sent out directly from the generating station busbars for local transmission.

DIESEL POWER

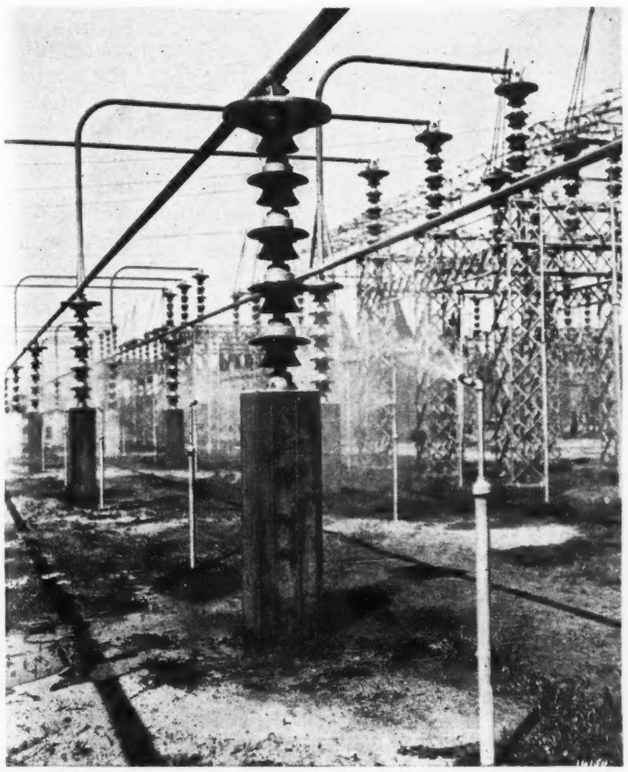
An imposing group of papers was presented in the session devoted to stationary internal-combustion engines and research work in this field.

In a paper entitled "Latest Development of Diesel Engines, With Particular Reference to Their Employment for Peak Load Operation" M. Gercke and Dr. A. Bannwarth of Germany declared that Diesel engines are the most suitable peak-load and stand-by prime movers for the electricity supply, because they are constantly fit and ready for immediate starting and for full-load service at any time without preliminary preparation and without useless consumption of fuel.

The authors listed the following ways in which the maximum capacity of Diesel engines can be greatly in-

creased: (1) increasing cylinder dimensions; (2) increasing the number of cylinder per engine; (3) coupling several engines through step-up gears for driving high-speed generators; (4) developing special super-high-speed and super-high-efficiency engines.

Based on successful experiences on the motorships Milwaukee and St. Louis of the Hamburg-American line, the authors felt that two, and even four, sets of Diesel engines could be coupled by gears to one shaft



Experiments on dust removal by sprays (from paper by Robert Sibley)

driving a big generator, with a capacity as high as 30,000 to 36,000 kilowatts.

A. L. Bird, for the British Marine Oil Engine Association, presented a paper on "Some Characteristics of Nozzles and Sprays for Oil Engines." In this he outlined the results obtained in some rather interesting experiments, in which the flame was observed and photographed through a heavy window in a special experimental cylinder.

In "Notes on Heavy-Oil Engine Research" Alan E. L. Chorlton, for the British National Committee, referred to the work of Mr. Bird, whose paper has already been mentioned. Mr. Chorlton said that if the turbulence is too severe there is a tendency for the flame to be extinguished.

In England the design of heavy oil engines, he said, tends toward the use of airless injection in fuel; the development of high-speed types (preferably four-stroke-cycle); increased use of double-action, and the two-stroke-cycle with the slow-speed engine; and increased use of supercharging with scavenging, the air pump being sometimes operated from exhaust-gas-driven turbines.

"Combined Internal-Combustion and Steam Operated Engines" was the title of a paper by Dr. F. Merkl (for the Austrian National Committee). He declared that the well-known method of combined internal-combustion and steam operation proposed by William Still does not lead to satisfactory results, as the steam is generated outside the cylinder. In place of this he proposed the water under pressure, and in a sequence of increasing temperatures, be passed through all the cooling compartments of the internal-combustion engine (stuffing box at the steam side, cooling slot in upper cylinder frame, cooling space in upper cylinder cover, cooling jacket of exhaust box) and then sprayed onto the inner piston wall. This, he said, will eliminate the necessity for water-cooling the cylinder wall.

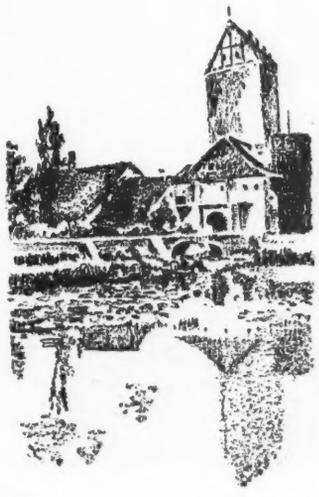
The machine can be equipped, with little cost, it was stated, for taking considerable overload and may be connected to a steam heater and a hot water heater. It also permits, according to Dr. Merkl, the use of inexpensive lignite as a fuel for gas-engine-driven electric generators, while the tar oil obtained from distillation of lignite may be used for driving Diesel engines in peak-load stations. Dr. Merkl claimed also that operation of an ordinary steam engine can be improved by the admission of superheated water in place of steam.

DIESELS IN U.S.A.

In a paper of striking frankness, J. Kuttner (A.S.M.E.), outlined "The Development of Stationary Diesel Engines Under the Conditions of American Power Economics." Mr. Kuttner placed equal emphasis on the negative and positive aspects of the Diesel engine situation as it exists in America and called particular attention to those factors—economic, business, and psychological—that differentiate the American situation from that in Europe. He made clear that the quality of a design should be judged only in terms of its environment.

"Engines designated as 'high types' from the European viewpoint may be quite useless in the American economic scheme. Actual experience with some complicated designs imported from Europe substantiates this and confirms the wisdom of examining American economic conditions first before attempting to interpret American designs of power-plant Diesel engines.

There is a little marginal business for Diesel engines in this country, Mr. Kuttner stated. In some districts the Diesel triumphs over competitive sources of power by a wide margin, and is sold with little competition, except between the various manufacturers of Diesel engines. In other districts the field may be entirely closed.



"It is estimated," said Mr. Kuttner, "that 20 per cent of all the Diesel engines manufactured in America are used in central generating stations. If to these be added the engines employed in private plants the result is that about 40 per cent of the total American Diesel output is devoted to the production of electric current."

[The July 1 number of *Power* will report the second week of the Conference.—EDITOR.]

World-Wide Broadcast Feature of N.E.L.A. Meeting

A WORLD-WIDE BROADCAST, the greatest in the history of radio, was the outstanding feature of the National Electric Light Association convention, held last week in San Francisco, Calif., from June 16 to 20. Starting at noon, Pacific Coast time (9 p.m., Berlin time), on June 18, the broadcast included short talks by such prominent men as Lord Derby and Senator Guglielmo Marconi in England, Dr. Oskar von Mueller and Dr. Carl Koettgen in Berlin, Matthew S. Sloan and Owen D. Young in San Francisco, and Thomas A. Edison in Orange, N. J. Through a record-breaking hook-up of land wires, submarine cables and short wave radio stations, it was heard in every civilized country of the world. Some idea of the magnitude of the undertaking can be gleaned from the illustration on the opposite page, produced by *Power* artists in cooperation with C. S. Hammond & Company.

Opening the program from San Francisco, President Sloan stressed the importance of the interchange of ideas between nations for the promotion of engineering, economic and social progress. Dr. Koettgen pointed out that engineers "know no difference of races and no boundaries of countries." Speaking on the benefits to humanity of the development of power, Lord Derby said that through such co-operative efforts as the World Power Conference, "there will be evolved a wiser, kinder, truer internationalism, linking closer the peoples of the earth."

Dr. von Mueller emphasized the value of scientific research in furthering engineering and industrial accomplishment. Citing the enormous strides made in the art of radio communication, Senator Marconi mentioned the future possibilities that lie in the transmission of power without wires. Mr. Young acclaimed the pioneers in the field of science, saying that "the application of new discoveries to our needs is our most productive occupation." Praising the development of science and engineering in the last 50 years, Mr. Edison closed the program with greetings to his many friends.

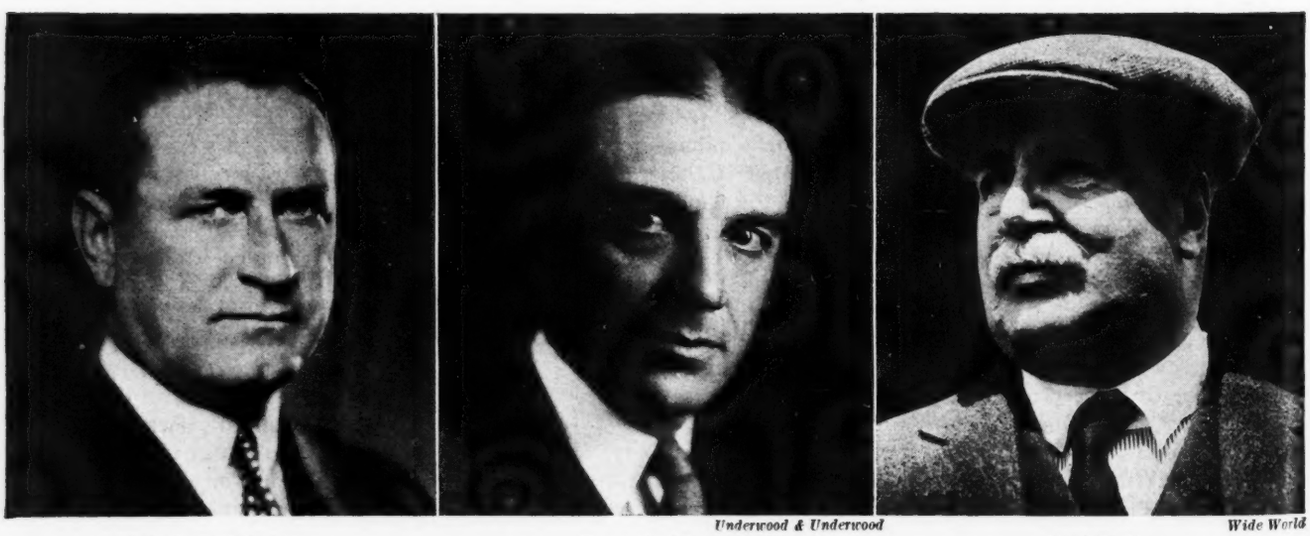
Preceding the broadcast the convention opened with a general session on Tuesday morning, June 17, at which President Sloan reviewed the progress made by the association and the power industry during the year. Despite the fact that "our business in output is reflecting the present conditions in general business," he cited the latest figures to show that the light and power industry will expend this year more than a billion dollars for the extension of its facilities.

"For the twelve months ended April 1, 1930, the electric companies generated 92 billion kilowatt-hours," he said, "an increase of 9 per cent over the previous year. Their gross revenue from sales was $1,980,000,000, an increase of nearly 8 per cent. In this period there was a severe curtailment of sales of industrial power, but revenue losses were made up by increases in street lighting, commercial lighting, and domestic service."

The trend of power generation in California away from hydro-electric developments and toward steam plants, and the continued increase in the cost of new construction, were the two chief characteristics of the discussions at the engineering national section session on Tuesday afternoon.

Speaking on the "future of water-power development in California," A. H. Markwart, vice-president of the Pacific Gas & Electric Company, said that "under the circumstances which now prevail it is natural to ques-

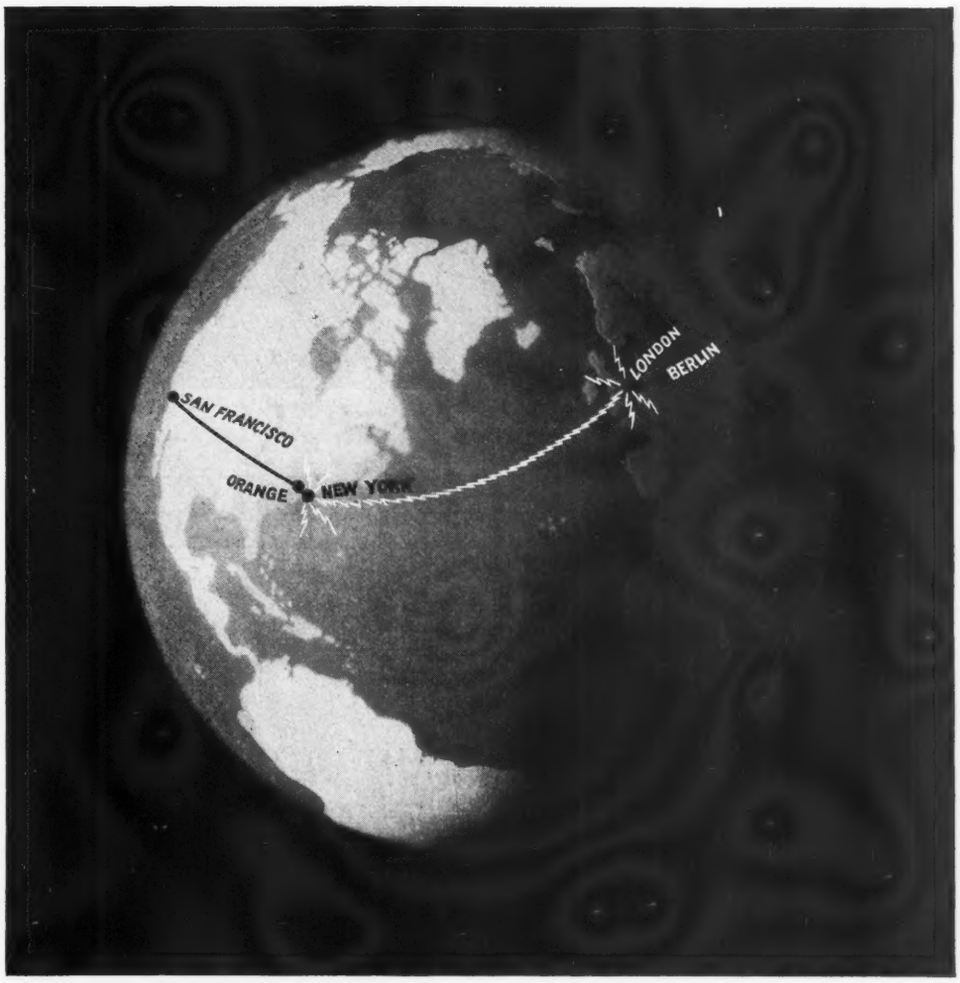
THEY TALKED FROM NOON TO 9 P.M. AND FINISHED IN 45 MINUTES



Underwood & Underwood *Wide World*

Matthew S. Sloan **Owen D. Young** **Lord Derby**

tion the future of hydro power in California despite the fact that hydro development has been actively prosecuted for more than four decades to the economic advantage of the state." One of the outstanding reasons which he gave is the constantly mounting cost of water-power development "because as a general thing the remaining sites cost more to develop and are less accessible than those sites which have already been developed." He also called attention to the fact that the output from existing plants has been reduced because of sub-normal rainfall.



In his opinion, a combined hydro and steam system can generate "mingled energy" more cheaply in California than could one generating all energy from either source alone, providing the load factor is fairly high. "No matter what fuel economies and fuel prices are," he said, "steam power, as will be observed, has been and always will be required in connection with hydro for reasons other than best economy in kilowatt-hour production."

F. B. Lewis, vice-president of the Southern California Edison Company, discussing the trend of power generation in southern California, said that in so far as his company is concerned it is "definitely toward the use of steam-generating equipment for additional plant expansion, and has been so for the past five or six years, to an increasing degree." He declared that the steam plant has come to stay in California.

"The increasingly higher cost levels at which additional water power can be developed, and also the lowering output cost of steam production," said Mr. Lewis, "are both in the same direction in their effect of crowding water power, if it is to qualify in this economical struggle with steam, to the pre-requisite of producing prime power at larger and larger load factors. Under conditions of high output cost for steam production, secondary water power could be utilized in conjunction with a small amount of steam power, to realize a lower combined cost of production, than could be obtained by steam alone.

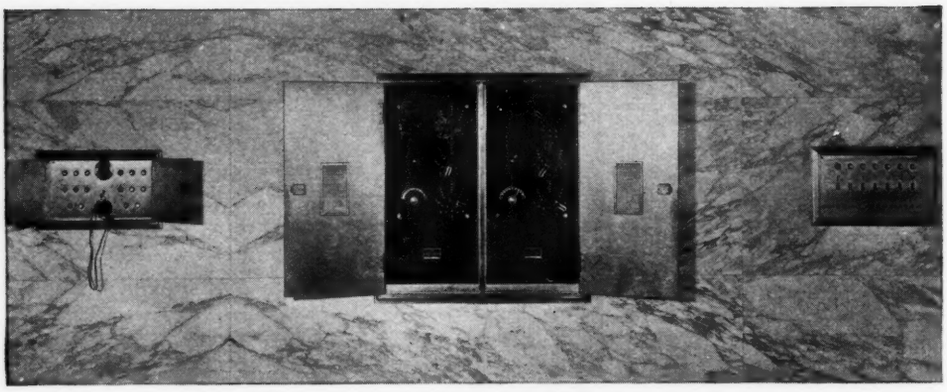
"With the tremendous oil and natural-gas resources of southern and central California, offering a continuation of a favorable fuel supply, supplemented by practically inexhaustible resources of coal located in adjacent states and obtainable at reasonable prices, together with the prospect of still further economies in steam generation, there is a very good indication that conditions will continue to favor steam generation indefinitely."

Speaking on the trend of costs, A. H. Kehoe, electrical engineer of the United Electric Light & Power Company, pointed out that "while technical advances of the past may have produced in some quarters an impression that the utmost in system improvements has been attained, it is my belief that great gains are still to be had from engineering developments.

"While the situation is not yet critical," he said, "the ominous sign on the technical horizon is the continued increase every year of the average dollars invested in our systems for each kilowatt of generating capacity. Despite a gradual reduction in generating plant costs from 1922 to 1929, which amounted to approximately 12 per cent, there have been increases in total system costs of 20 per cent. These have reached a total of $375 of system investment for each kilowatt of generating capacity installed in 1929.

"However, the system investment required per kilowatt-hour sold has shown a gradual decrease, particularly since 1926. From segregated figures of average investment costs it is found that all this reduction has occurred in power plants and in certain miscellaneous items, such as service buildings, offices, etc."

Officers elected for the coming year include: president, W. A. Jones, executive vice-president of Henry L. Doherty & Company; vice-presidents, J. F. Owens, Oklahoma Gas & Electric Company; Marshall E. Sampsell, Central Illinois Public Service Company; Edwin H. Gruhl, North American Company; and treasurer, P. S. Young, Public Service Gas & Electric Company, New Jersey.



Automatic scheduling system for two banks of elevators in a large office building

AUTOMATIC DISPATCHING Improves Elevator Service

Elevator traffic in buildings can be most efficiently handled when the cars are kept equally spaced in the hoistways. A system is here described that dispatches the cars automatically from the terminal landings, at equal time intervals.

By F. A. ANNETT
Associate Editor of Power

A BUILDING may have a sufficient number of elevators, but if they are not used efficiently the service will be unsatisfactory. An adequate signal system is essential to the operation of modern elevators. Operators must be informed as to where the waiting passengers are and the direction in which they wish to go. It is also necessary for waiting passengers to know when cars are approaching and the directions in which they are going.

It is of equal importance to operate the cars on a proper schedule. Unless this is maintained at all positions in the hoistway, the service will be erratic—too many cars may be passing a given point in the hoistway, while at other points the service is inadequate. Service may be irregular even when the cars are controlled at the ground floor by a starter.

As an example of how the elevator service may vary under manual dispatching, a check taken in one building showed that the departure time varied from 30 to 80 sec. between cars leaving the ground floor. In some cases the delay between cars was 2½ times as long as it was at others. The service at the intermediate floor was even more uncertain. For instance, a check taken at the seventh floor showed that the time between cars passing this floor in the down direction varied from 30 to 120 sec. This variation occurred in a building where if the cars had been run on schedule the interval between them in either direction would have been about 50 seconds.

The preceding figures show that the off-schedule time tends to increase as the cars travel up and down the hoistway. Even though the interval between departures at the ground floor did not exceed 80 sec., up in the hoistway the maximum time was 120 sec. This is what is to be expected, since the car leaving the floor after a long waiting period would generally have a greater number of passengers to deliver, and more passengers would have accumulated on the intermediate floors for the car to handle. All of this tends to slow down the car on its trip up and down the hoistway. Slowing this car up allows the following car to catch up with it, and two cars may answer the same signal from a given floor, which adds further confusion to the service.

These conditions emphasize the necessity of uniformly dispatching the cars from the ground floor and maintaining this schedule throughout the trip. It is practically impossible for a dispatcher to do this. And he usually has many other duties to perform in serving the passengers, all of which distracts his attention from the problem of having the cars leave the floors on a definite schedule.

In recent years considerable attention has been given to relieving the starter of dispatching the cars, making operation automatic and providing means to show the operators if they are running on schedule. Such a system of automatic elevator control has been developed by the Elevator Supplies Company, Inc. In each car there is a three-light unit, Fig. 1, containing a green, a red, and a white light. The green and the red lights are for dispatching the cars at the terminals, and the white lights show the operators if the schedule is being maintained. The machine for operating the system is shown in Fig. 2. It consists of three motor-driven arms *A* for flashing the lights. In the top of the cabinet are duplicates of the green, the red, and the white lights in the cars. Below these lamps is a set of starter's call-back buttons, which are connected to the green light in each car. The dispatching cabinet is near the starter's station on the ground floor.

The dispatching machine is designed for scheduling a group of three to five elevators. For a group of five elevators, with the contacts placed in the end of the arms, Fig. 2, they will make contact with buttons 1, 2, 3, 4, and 5, and give signals to all five elevators. If the arms are properly spaced the cars will be dispatched on equal time for either direction. For example, if the round-trip time is 180 sec. the cars will be signaled to start at 36-sec. intervals. When it is time for elevator 1 to start a green light will flash in that car. When it is time for the operator to leave the top floor a red signal will flash in his car. This will be 90 sec. after the car leaves the ground floor. When the car should be half way down the hoistway the white light will flash. If the car is above the half-way point, the operator knows that he is behind schedule. On the other hand, if the car is below the half-way point the signal shows that the schedule has been exceeded. Thirty-six seconds after No. 1 car leaves the ground floor the operator in No. 2 car will receive a green signal to leave. Similarly, 36 sec. after No. 2 car starts, No. 3 will get a signal to go. This system of equal up and down time is the one that is normally used between rush periods. With this set-up the arms that flash the green, the red, and the white signals make one revolution in 180 seconds.

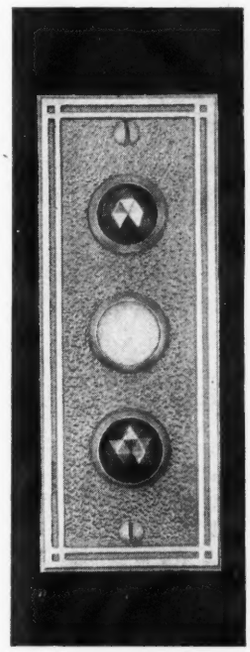


Fig. 1 — Operator's car signals

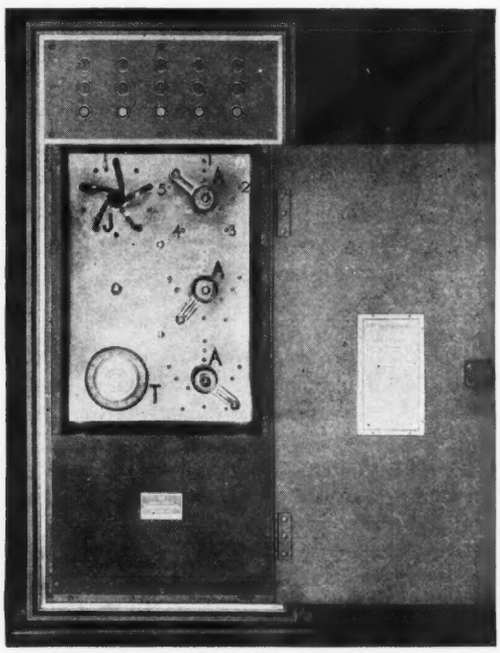


Fig. 2—Machine for automatically scheduling a bank of elevators

In rush periods the up and the down traffic is out of balance. During the morning-in and noon-in periods traffic is virtually all in the up direction, while during the noon-out and evening-out periods the traffic is very largely in the down direction. To take care of these conditions the red and the white lights can be adjusted to allow a longer running time in the direction of heavy traffic. For instance, if the round trip time is 180 sec. the arms on the automatic dispatcher may be so placed that the time in the direction of heavy traffic will be 100 sec. and in the opposite direction 80 seconds.

Instead of using the white lights to give an intermediate signal to the operator, it may be employed to give a preliminary starting signal at the lower terminal landing. When used for this purpose the white light flashes about 4 sec. before the green light. Generally a buzzer is arranged to ring when the green starting light flashes. It has been found that the chance of an operator missing a signal at the ground floor is many times that at the others, on account of the heavier traffic at the former. Where the cars run to a basement floor the white light may be used to signal the leaving time from this floor and the green light used for the usual purpose at the ground floor.

The schedule may be speeded up or slowed down by adjusting the calibrated timing device shown at *T*, Fig. 2. This adjustment is simple and can be easily made. When it is desired to take a car out of service one of the jacks *J*, corresponding to the car number to be taken out of service, is pulled out of its receptacle and placed in a dead hole between jacks. The contact on each rotating arm is moved in toward the center to a position corresponding to the number of cars in service and an adjustment is made in the round-trip time at *T*, if this is necessary. The change in the dispatching of the cars can be made easily and quickly.

The green and red lights at the top of the dispatching cabinet, as previously mentioned, correspond to those in the different cars and flash in synchronism with them. These show the starter if the car operators are getting the signals to start at the terminal landings. The call-back buttons are connected to the green lights in the cars. When a button is pressed it causes the green light in the car, corresponding to the button, to flash, and at the same time the operator receives an audible signal. Code calls may be worked out between the dispatcher and operators to suit the particular conditions under which the cars operate.

While it is important that cars leave the terminal landings on schedule, the intermediate floors are of equal importance. This is particularly true where passengers are waiting on the floors. When they press the button they expect almost instant service, regardless of the fact that the elevators are serving other floors at that instant. Even though it is not possible to give a perfect service, automatic scheduling insures intermediate floor service that approaches terminal floor timing within 10 sec. This additional time is necessary to cover the irregularities of the traffic in a building for which it is not always possible to make immediate adjustment. Usually the maximum waiting time at the intermediate floors will approximate the terminal timing interval or may even be less during the periods of uniform travel in both directions.

This system of automatic dispatching is best adapted to groups of four or more elevators. Its installation will increase the efficiency of the elevator service over that of manual dispatching and give more satisfactory service. Equal spacing of the cars in the hoistway will allow the regular signal system to operate at its greatest efficiency by preventing cars from overrunning each other and making false stops. It is also possible to hold the parking time at terminals to a minimum, and keep the cars in operation a maximum of time. This allows of handling a greater traffic with the same number of elevators than is possible with manual dispatching, or the same traffic may be taken care of with a smaller number of cars in service.

STATION A

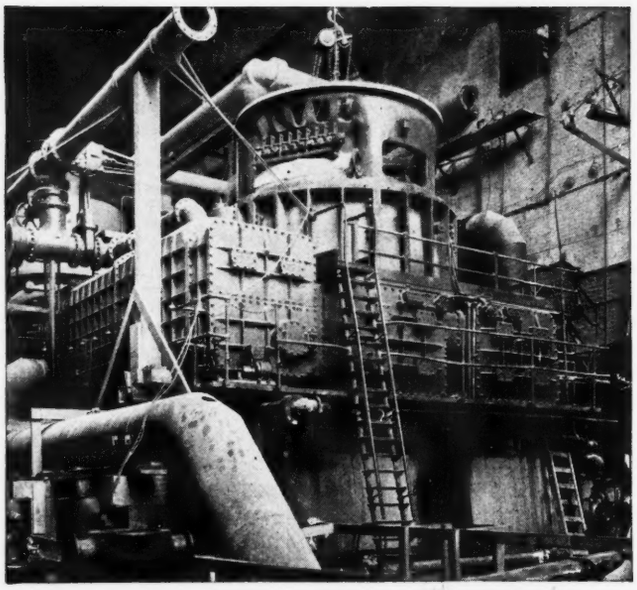
Twenty Years Later

IN 1910 the power station of the San Francisco Gas & Electric Company was the largest in the West. It contained ten engines, six of them operating condensing. In that year a 12,000-kw. vertical turbine and a 25,000-sq.ft. dry-tube base condenser and auxiliaries were installed. The capacity of the turbine was equal to that of eight of the engines, although it occupied less floor space than one of them.

The San Francisco Gas & Electric Company is now a part of the Pacific Gas & Electric Company, the change in name bearing witness to the increased scope of its activities. The power station, now Station A, as previously announced in these columns, is being remodeled to accommodate 1,400-lb. boilers and two 50,000-kw. vertical-compound turbine units and 34,000-sq.ft. Foster Wheeler condensers. The plant will ultimately contain four such units, or a total of 200,000 kw., without increasing the ground area of the original station. The boiler room roof is being raised slightly. To make room for these two new units, the 12,000-kw. unit of 1910, a similar 15,000-kw. unit installed in 1913, and two 3,500-kw. engine-driven sets had to be removed. The photograph was taken during the removal of the 12,000-kw. unit. The generator has been taken off the turbine, which rests on the two condensers which were built into the turbine base.

COMPARISON OF THE OLD AND NEW UNITS

	Year Installed 1930	1910
Size of unit, rated kw.	50,000	12,000
Maximum output, kw.	62,500	13,000
Turbine	G.E.-Curtis, vertical-compound, horizontal shaft	G.E.-Curtis, vertical
Condenser, type	Foster Wheeler, horizontal 2-pass, direct-flow	Foster Wheeler, horizontal 2-pass, dry-tube, base
Steam pressure, throttle, lb.	1,250	175
Steam temperature, deg. F.	750	478
Throttle water rate, at rated load, lb.	8.4	14.6
Throttle water rate, at maximum load, lb.	8.4	14.6
Condenser water rate, at rated load, lb.	6.0	14.6
Condenser water rate, at maximum load, lb.	6.4	14.6
Condenser size, sq.ft.	34,000	25,000
Sq.ft. per rated kw.	0.68	2.08
Sq.ft. per maximum kw.	0.545	1.92
Tube size, in.	¾ O.D. No. 16 ga.x22-0	1 O.D. No. 18 ga.x17-2
Pounds of steam condensed per sq.ft., rated load	8.85	7.0
Pounds of steam condensed per sq.ft., max. load	11.75	7.6



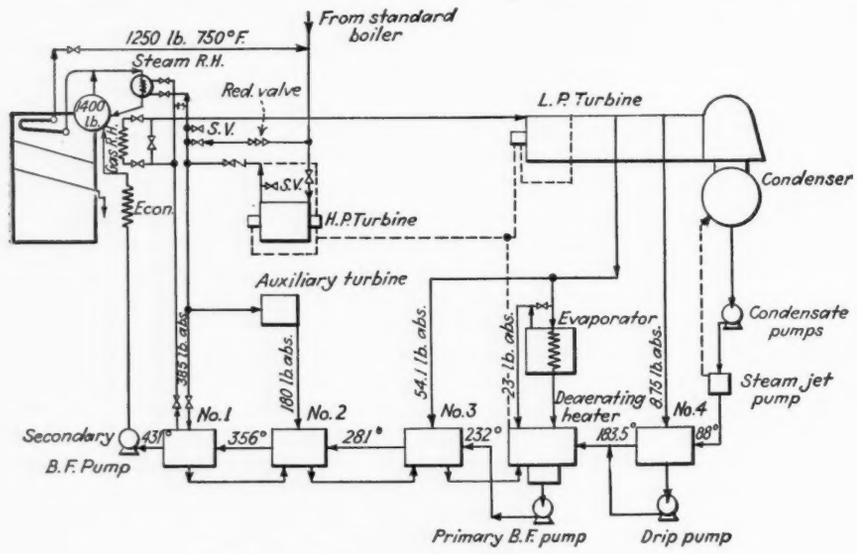
12,000-kw. vertical turbine and 25,000-sq.ft. dry-tube condenser, installed in 1910, being removed to make room for second 50,000-kw., 1,200-lb. unit

In the upper inner corners of the base condenser waterboxes connections may be seen for the feed-water heater. The hot-well pump discharged through this heater, which was an integral part of the condenser. Temperature of the condensate leaving the heater, under test conditions, was the same as the temperature of the vacuum. In the new unit this result is obtained in the reheating hotwell, which also deaërates the condensate, without any external piping or other complication.

The dry vacuum pump on the old unit was a 16x36x24 in. horizontal corliss, close clearance type, with two semi-rotary air valves. A two-stage steam-jet air pump with combined surface inter- and after-condenser serves the new unit, and occupies about the same space as the steam end of the old pump, while handling more air per pound of steam.

Two 5-in. single-stage hotwell pumps, turbine-driven, served the old unit, while two 6-in. Wheeler two-stage pressure-sealed pumps, driven by variable-speed motors, will supply the 50,000-kw. unit.

The 12,000-kw. unit went into service Jan. 24, 1911, and was retired April 15, 1930—a record almost equaled by the 15,000-kw. machine, which started Dec. 15, 1913, and shut down for the last time Aug. 8, 1929.

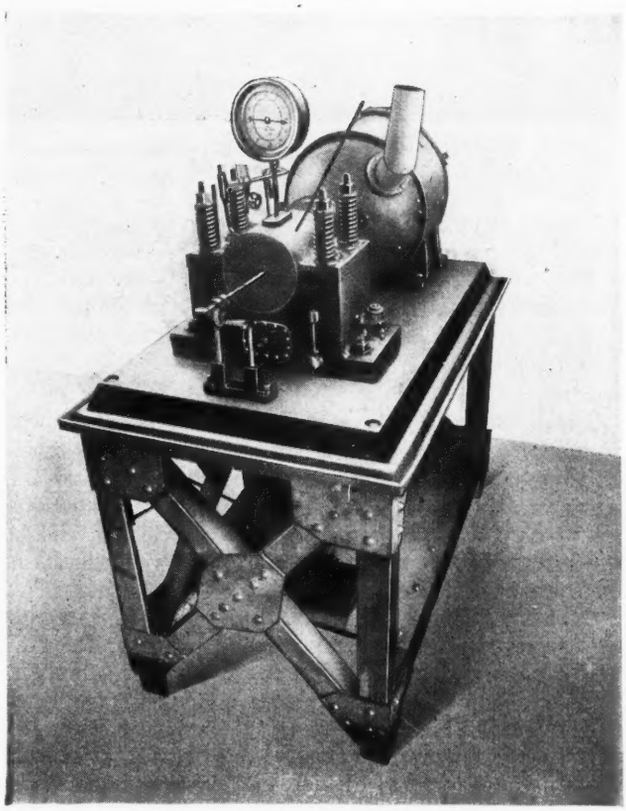


Heat balance diagram of the 50,000-kw. turbine

Purchasing OIL *on the Basis of* SERVICE-COST

By LIEUT. C. A. GRIFFITHS
United States Navy

The Navy Department is responsible for providing proper lubricants for turbines in destroyers and cruisers, Diesel engines in submarines, reciprocating engines in older or smaller vessels, and for internal-combustion engines in motorboats and aircraft. The method adopted for selecting the most economical lubricating oils for these various services is equally applicable to land practice



End view of the endurance testing machine at the Annapolis engineering experimental station

ANNUALLY, during the month of May, the navy enters the market for a million and a half gallons of lubricating oil to cover its many and diversified requirements for the ensuing fiscal year. In addition to contracting for this quantity of lubricating oil, 26 other Federal agencies purchase another million and a half gallons for their respective needs under the same contract. This 3,000,000 gal. covers the lubrication requirements of practically all types and forms of machinery operated by the government.

To insure the navy's receiving lubricating oils of acceptable quality, minimum requirements were long ago established. During annual replenishment periods oils were purchased from a list of bidders offering oils that met these minimum requirements. Obviously some were better lubricants than others. To refine oils costs money. The greater the degree of refinement, the greater are the costs, and, in proportion as refinement is more carefully carried out, other things being equal, the better will be the product. Consequently, the better lubricants were sold at a higher price.

The laws require acceptance by any government agency of the lowest bid on material meeting specifications. Purchase of lubricating oils on a strictly specification basis, award being made to the low bidder, resulted in buying oils that may have just met the minimum requirements. As this practice was not, in the long run, true economy, the problem of evaluating forced-feed and motor-cylinder oils was undertaken.

It is generally conceded that a new forced-feed oil is a better lubricant than the same oil after protracted use. Forced-feed lubricating oil in a turbine bearing or in a gasoline engine bearing under usual temperatures and pressures undergoes working. During the transition from new to old certain changes in the characteristics of the oil occur. If the changes in one oil due to working be greater than the changes in the same properties of another oil, the conclusion is naturally drawn that the latter oil is the better of the two.

All mineral lubricating oils have a number of essentially variable characteristics. In prosecuting the investigation, forced-feed and motor-cylinder oils were first standardized in nine classes, according to their viscosity measurements. The range between each class was sufficient to permit of selection of a suitable oil for every forced-feed application.

Symbol numbers[1] were assigned to the oils to serve as an identification of the group into which each oil fell.

[1]The symbol system of identifying lubricating oils was described more fully in the Aug. 6, 1929, number of *Power*.

This eliminated the ambiguous terms, "light," "heavy," etc., and substituted in their stead a number, the last three digits of which definitely classed it in the appropriate viscosity group. The first digit indicates the kind of oil, as, refrigeration, forced-feed and motor-cylinder, aviation, marine engine, compounded, etc.

Identical methods of testing various oils is of first importance in evaluating them, and to obtain this as many variables as possible were eliminated. Next is the requirement that the method approach actual operating conditions as closely as possible.

Laboratory chemical and physical tests have for years been well standardized, are well understood by petroleum chemists, and have given consistent results. Practical tests, however, have not shared the same fate. Internal-combustion engines and similar apparatus on which actual service tests of lubricating oils can be run have inherent mechanical differences too numerous and too varied to permit of standardization on any basis where consistent results are to be expected on a material so susceptible to the effects of variables as lubricating oils.

To provide for standardizing tests on different oils, and in striving to reduce the variables common to other forms of practical testing apparatus, yet to give the oil under test a thorough practical working, the engineering experiment station at Annapolis devised an endurance testing machine. This machine consists of a single journal, 6 in. long and $3\frac{13}{16}$ in. in diameter, uniformly loaded at a bearing pressure of 150 lb. per square inch by a spring-loaded bearing cap. It is motor driven at a constant speed of 2,000 r.p.m. The test oil is supplied to the upper on-side of the bearing at 15-lb. gage pressure by a gear-driven pump, and circulates in a closed system. The duration of the test is 100 hr., when the machine is stopped and the oil removed and examined to determine its condition and the nature of the changes that have taken place. It is tested chemically and physically and the results are compared to the same properties observed in a new oil.

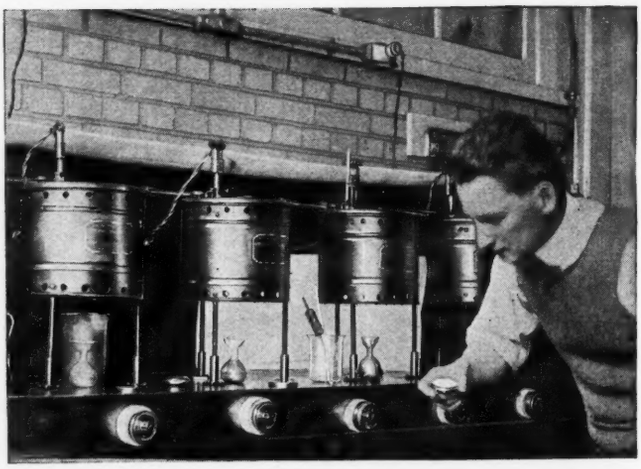
These investigations disclosed that only four of the original important characteristics of an oil (namely, viscosity, precipitation, neutralization, and carbon residue), change to an appreciable degree during the 100-hr. working. It was also discovered that the amount of change varied largely with different kinds of oils within a symbolized class. The four important changeable characteristics on which the work value of an oil is based are as follows:

Viscosity—A measure of the internal resistance of the oil to flow. It is an indication of the "body" of the oil; whether it be light or heavy, fluid or viscous.

When a forced-feed mineral oil is worked under normal temperature and pressure, without dilution or the introduction of foreign matter, the viscosity will increase in a degree dependent upon the oxidation of the oil, the formation of sludge, the base of the crude, and the presence of unsaturated compounds, free carbon, and other imperfections, many of which can be diminished by careful refining. Hence, the change in viscosity becomes a most important consideration, and one which can be evaluated.

Viscosity is measured by the seconds it takes a given quantity to flow from a calibrated orifice at certain temperatures. Measurements are made at 100, 130, and 210 deg. F., and from these readings, before and after test, the viscosity work value is calculated from the formula:

$$\textit{Viscosity work value} = 1.00 - \frac{\textit{(Final Viscosity)} - \textit{(Initial Viscosity)}}{\textit{(Initial Viscosity)}} \times \frac{1}{C}$$



A battery of Viscosimeters at the Engineering Experiment Station

An upper limit above which the rise in viscosity is considered to render the oil unsatisfactory is established. In the case of aviation oils, this limit is set at 25 per cent increase, and for other oils it is set at 20 per cent. C, therefore, equals 0.20 or 0.25, as the case may be.

Precipitation—An indication of the sludge-forming tendency of an oil.

Certain impurities in a mineral oil, either from contamination in handling or from imperfect refining, while not being particularly evident in a new oil, will cause oxidation of the oil and the formation of sludge. The latter is a precipitation of the oxides of hydrocarbon, and becomes increasingly greater as the oil is worked at running temperatures and pressures in contact with air. The tendency of an oil to precipitate sludge can be measured both before and after working, and it forms the basis for the second of the four important work-value factors.

All oils will oxidize to a greater or lesser degree; so, with an established maximum initial content of oxides, an initial rejection point after working, and a final rejection point, the effect of increased oxidation and sludge formation is evaluated by the formula:

$$\textit{Precipitation work value} = \frac{\textit{(Final Rejection Point)} - \textit{(Final Content)}}{\textit{(Final Rejection Point)} - \textit{(Initial Content)}}$$

Neutralization—An indication of the presence of harmful acids in a mineral oil.

Acids of mineral origin, present during refining, if allowed to remain in the finished oil, are harmful to the metal surfaces with which they come in contact. A well-refined mineral oil will show practically no acid reaction when the oil is new, and very little after the oil has been used. A mineral oil containing animal or vegetable oils will, under operating conditions, develop an acid reaction, and is to be avoided.

The neutralization of any acids found in a mineral forced-feed oil is a measurable quantity, and forms the basis for the third important factor in the evaluation of the oil. The evaluation is obtained by the formula used for precipitation work value.

Carbon Residue—An indication of the carbon-forming propensity of an oil.

All mineral lubricating oil is a form of hydrocarbon. In addition to the carbon-hydrogen molecules there may also be present some molecules of free carbon, particularly if the oil was imperfectly refined. During work under normal conditions, the hydrocarbon composition may change, liberating both carbon and hydrogen in

minute quantities. This liberated carbon is retained in the oil and adds to the free carbon already there. The tendency of an oil to form carbon is a measurable quantity and, as the percentage of carbon increases during work, the fourth factor of the evaluation is obtained.

Owing to the difficulties of refining the heavy, more viscous oils, permissible maximum carbon residue contents vary for different oils. The carbon content for all forced-feed and motor-cylinder oils must lie within the following limits:

Symbol No.	Maximum Content Initially Acceptable, Per Cent	Initial Rejection Point, Per Cent	Final Rejection Point, Per Cent
2110, 2135, 2190	0.50	0.55	1.05
2250, 2310	1.00	1.05	2.05
3080, 3100, 3120	1.50	1.55	3.05

The work value for carbon residue is taken as the average of two work values, one on the new oil, the other on the used oil. The work value on the new oil is obtained from the formula:

$$\textit{Work value} = \frac{\textit{(Initial Rejection Point)} - \textit{(Initial Content)}}{\textit{(Initial Rejection Point)}}$$

The formula for precipitation work value is used to evaluate the increase in carbon after working.

Illustrating the application of this method of determining the final work value of a lubricating oil, which is an average of the three viscosity determinations, the precipitation, the neutralization, and the average of the two carbon residue determinations, we find for a typical satisfactory forced-feed and motor-cylinder oil, Symbol 2190, the following:

	Test Results Before	Test Results After	Work Value	Final Work Value
Viscosity at 100 deg. F.	630	648	0.886	.....
Viscosity at 130 deg. F.	286	293	0.902	.....
Viscosity at 210 deg. F.	75	77	0.893	.....
Average viscosity	....	....	....	0.894
Precipitation	0.00	0.05	0.950	0.950
Neutralization	0.06	0.20	0.853	0.853
Carbon residue, before	0.81	....	0.478	.....
Carbon residue, after	....	0.98	0.924	.....
Average carbon	....	....	.....	0.701
Final work value of the oil	....	....	.....	0.8495

The next step in the selection and purchase of an oil is to determine from a number of satisfactory samples the one having the lowest *service cost* per gallon. Service cost is determined by dividing the bid price per gallon by the work value. Illustrating how the navy obtains the lowest service cost from a number of bidders, each having a different price per gallon and a different work value for their oil, the following tabulation of bids, A, B, and C is typical:

Bidder	Bid Price per Gallon	Work Value	Service Cost per Gallon
A	$0.65	.8495	$0.765
B	0.76	.8724	0.871
C	0.52	.6341	0.820

On a straight specification basis the award would be made to bidder C at the lowest price per gallon, but the work value of this bidder's oil is so low that his service cost is high compared to that of bidder A. Bidder A would get the award on a service-cost basis.

In judging the service value of a lubricating oil, the work-value method devised by the navy has proved that it will disclose the difference between two oils both of which meet the minimum requirements, one, however, being exceptionally good, while the other barely meets the requirements. As a result a longer-lived oil is secured, the wear and tear on machinery is reduced, and an actual saving in dollars and cents is obtained.

Forced-Draft Firing of Pulverized Fuel

By OLLISON CRAIG

Consulting Engineer Riley Stoker Corporation

THERE are two general methods of supplying secondary air for burning pulverized fuel. One introduces air under pressure. It is commonly referred to as forced-draft firing. In the other method air is caused to enter the furnace by utilizing the furnace suction. This method is called natural-draft firing. Neither definition takes any account of the possible use of an induced-draft fan, because the means by which furnace suction is obtained, either by fan or stack, is immaterial.

Most of the unit-pulverizer installations being put into service at the present time are being arranged for forced-draft firing. This is true regardless of the fact that the cost of auxiliary equipment is greater than that for natural draft. It is obvious that there must be certain advantages in the forced-draft method, or the additional expenditure for auxiliary equipment would not be justified. Also the advantages must result, finally, in decreased steam cost sufficient to pay fixed charges on the extra costs and to pay those costs in a reasonable time.

It has been the practice in the past, with natural-draft firing, to introduce air through ports, or openings, in the furnace walls. These ports may communicate directly with the outside air, or air may pass through passages in the walls before entering the openings. The ports may be scattered over the walls at various elevations; may be placed in bands at only certain elevations; or may be confined to a single wall, usually the front. Dampering devices may be provided at all the ports in the form of swinging doors or butterfly dampers, or air may be controlled in wall passages leading to the ports. In the latter case, ports receiving air from a certain passage are controlled by a single damper.

The use of wall ports has been more common with vertical firing, in which coal and primary air are discharged downward through a furnace arch. Development of horizontal firing has made the use of ports more difficult, and it has become the practice to introduce all the secondary air through, or at points near, the horizontal burners.

Forced-draft secondary air is usually introduced into the furnace through the burners only, and for this reason horizontal burners appear to be better adapted to forced-draft firing. Furthermore, it has been customary to mix all the air of combustion with the coal in the burners, before discharging into the furnace, and under certain conditions of operation this would result in back-firing into, or overheating of, the burners. As steam requirements decreased, the rate of coal discharge decreased, and the velocity of discharge at the same rate would become less than the velocity of flame propagation, resulting in ignition of the mixture in the burners. Also, pulverized-fuel furnaces are of sufficient height to produce a decided stack effect, causing a positive pressure to exist under the arch, although a suction obtains in the remainder of the furnace. This pressure forces hot

gases, or even flame, around the metal portions of the burners, causing them to become overheated. Fuel adheres to this hot metal, accumulating and coking until the burners became choked and the mass of coked fuel ignites into flame. Horizontal forced-draft burners of improved design are not subject to these difficulties, since they are applied to a portion of the furnace usually under suction, and since primary air and coal do not need to mix with secondary air within any metal portions of the burners.

Air for forced-draft operation may be taken directly from the boiler room, may pass through passages in the furnace walls, before going to the burners, or may be received from air preheaters. Natural-draft operation is not feasible in connection with air preheaters, since in any case fans are required to move air through the heaters.

If secondary air is admitted through furnace wall ports and the flow of air is produced by furnace suction, the entrance velocity of the air will be low, because the pressure head producing the flow cannot be sufficient to give high-velocity jets. Assuming a furnace draft of

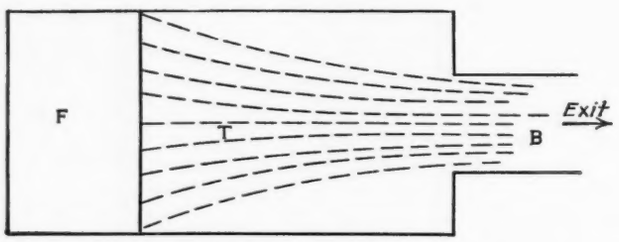


Fig. 1—Illustrates contraction of gases with negative pressure in the furnace

$\frac{3}{8}$ in. of water, the velocity would be 2,400 ft. per minute provided the flow was frictionless. Passage resistance would reduce this velocity to probably 1,500 ft. per minute or less.

Low-velocity air jets from wall ports cannot penetrate far into the stream of moving gases, and it will be only by the diffusing action of moving gases that air from the ports will be sufficiently distributed through the gas mass so that each particle of coal will find its proper portion of air and be completely burned. In addition, if more air at, say, 80 deg. enters a furnace in which the gases are at a temperature of 2,200 deg., the entering air will have a density five times that of the furnace gas. The air will then fall immediately along the wall and rise only after having been heated to furnace temperature. Examination of ash formation around air ports in furnace walls furnishes ample evidence of this fact.

The result of low jet velocity and precipitation of air is improper mixing—regardless of diffusion, since diffusion is a slow process and cannot complete proper mixing in the time available. The final effect in the furnace is higher excess air and higher carbon loss in ash than would be the case with effective mixing, which, in turn, would result in higher steam cost.

Again, if air is introduced through ports by furnace suction, an arrangement of ports which would produce reasonably good results at one rate of fuel burning would produce poor results at any other rate. At a given rate of fuel burning a flame would be obtained having a rather definite boundary. The relation of this boundary to the position of the ports might make the air most accessible to the fuel particles. At any other rate of fuel burning the flame boundary will be different; but the port arrangement remains the same and accessibility of air to coal particles will be changed, resulting in some particles receiving a deficient supply of air while a portion of the air passes through the setting as excess. The result is both high carbon loss and high excess air loss. Some compensation can be obtained by regulation of various dampers controlling air to individual ports, but an infinite variety of adjustments would be required to properly meet all conditions of operation. In practice an average setting of port dampers is obtained giving best average results; the dampers are then maintained in permanent position and the furnace draft more or less regulated to obtain sufficient air for combustion. However, with manual control, operators will rarely make proper changes of boiler outlet dampers to produce desired furnace draft, and either an excess or deficiency of air will follow from this cause, in addition to the other losses. Automatic control can be applied, either to the boiler dampers or port dampers, or both, but the multiplicity of adjustments required makes the application of automatic control to this method of pulverized-fuel firing rather difficult. It has been found that to give automatic control sufficient margin on which to operate an average lowering of CO_2 by 2 per cent is experienced compared to careful manual control. The advantage of automatic control in this case lies only in the fact that careful and constant manual control can seldom be obtained.

If pulverized fuel is fired through a horizontal burner and secondary air is passed by natural draft through the burner or through openings adjacent to the burner, comparatively large openings are required to pass sufficient air without excessive furnace draft. Velocities will be comparable with those previously mentioned. Air traveling at such low velocity does not contain sufficient energy to produce the violent turbulence required for

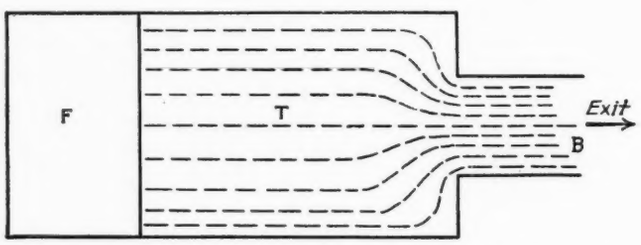


Fig. 2—Illustrates flow of gases with a positive pressure in the furnace

quick and thorough mixing of the coal and air. Diffusion must still be relied upon; and more time must be required for proper combustion, resulting in increased carbon loss.

Present practice of "forced-draft" firing, especially with the unit- or direct-fired system, is to use horizontal turbulent-type burners. Coal is delivered through discharge nozzles and secondary air is introduced under pressure through openings adjacent to or surrounding them, and both streams are directed to produce the greatest possible turbulence in the whole mass. Since both streams are introduced under pressure, velocities around 5,000 ft. per minute or more may be used, sufficient to produce quick and positive mixing.

With natural-draft firing greater suction will be maintained throughout the entire boiler setting than in the case of forced-draft firing. Greater suction throughout the setting is equivalent to having greater force acceler-

ating the gases, producing a contraction of the gas stream as it passes through the setting somewhat analogous to the vena contra of a vertical water jet.

Fig. 1 illustrates this principle diagrammatically: Assuming that the gases enter the tube space *T* from the furnace *F*, spread across the entire width of the setting, because of the accelerating force of the large suction, the gases will continually contract until they enter the outlet *B*. A portion of the heating surface will be out of the path of flow of the gases and will be ineffective for heat absorption, and the temperature of the gases entering *B* will be higher than if contact had been made with all the tubes.

If a positive pressure could be obtained and maintained through the setting, this contraction of gases would not exist. In this case the flow of gases would be as indicated in Fig. 2: The gases are forced out against the wall surface, which acts as a retainer holding the gas under pressure. All tube surfaces are passed by gases, whose temperature is less at the outlet *B*, since more opportunity has been provided for discharging heat to the tubes.

To permit positive pressure a gas-tight setting is necessary. However, forced-draft firing permits of lower suction in the setting and of more nearly approaching the condition of Fig. 2 than is possible with natural-draft firing. The result is a smaller heat loss to the exit gases.

Economy of steam production is affected by method of firing through obtainable capacity. Slow mixing with natural-draft operation limits the economical rate of fuel burning in a given furnace. As stated previously, forced-draft operation with rapid mixing permits more fuel to be burned economically in the same furnace. The result is greater possible steam production for a given expenditure of money, and the fixed charges apportioned to a thousand pounds of steam becomes less, making steam production more economical.

Summarizing, experience has shown that forced-draft firing produces greater turbulence and more complete mixing of secondary air with the primary mixture than is possible with natural draft; maintains more effective mixing at all rates; is more susceptible to easy and quick control and more adaptable to automatic control, affording greater flexibility in operation. It also provides means for obtaining and maintaining any desired CO_2; permits development of greater steam capacity and operation at lower minimum load with continuous firing; results in less setting leakage; affords greater heat absorption from the gases and less carbon loss; secures lower exit temperature of gases; provides greater over-all efficiency of steam generation, and reduces cost of steam through reduced fixed charges per unit of capacity.

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High-Pressure Pumping Station Operates Automatically

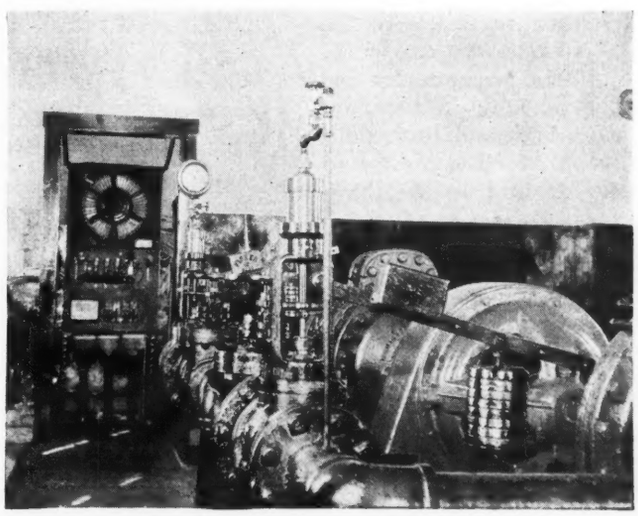
By R. M. Ryan
General Electric Company, Kansas City, Mo.

THE Empire Oil & Refining Company, at El Dorado, Kan., operates an automatic pumping station to supply water for various purposes to oil drilling lessees. Two centrifugal pumps, rated 250 gal. per min. at 300 lb. per square inch, are driven by 100-hp., 1,800-r.p.m., 440-volt slip-ring motors. The pumping station is automatic, maintaining a definite predetermined pressure on the line irrespective of flow within the range of the unit. Pumping service is continuous day in and day out, 24 hr. per day. The station is some six miles from the point of demand. The leases supplied with water cover some 18,000 acres. Water is supplied to the pumps by gravity flow from a lake owned by the city of El Dorado, and to the various lessees through a network of piping held under pressure by automatic control of the pumps.

Control equipment consists of a speed-regulating panel with a speed-regulating resistor and a motor-operated regulator. The regulator equipment is arranged to adjust the speed of the slip-ring motors so as to maintain a definite operating pressure for all values of water flow.

Only one pump is operated at a time, but transfer switches will allow operation of either pump. In addition, a hand compensator and slip-ring short-circuiting switch allow of operation of either pump at constant speed should any repair work be necessary on the control equipment, which provides overload protection and undervoltage release. The pumps will be restarted on failure of voltage only after the pilot motor returns the dial switch to the initial speed setting.

All pump and motor bearings are protected by temperature relays. Freezing of pump lines and valves is prevented by the use of thermostatically controlled electric space heaters. Flood and sign lighting, controlled by motor-operated time switches, gives the pumping station an attractive appearance at night. Any normal inspection and repair is performed by the present maintenance department, so neither day nor night attendants are needed.

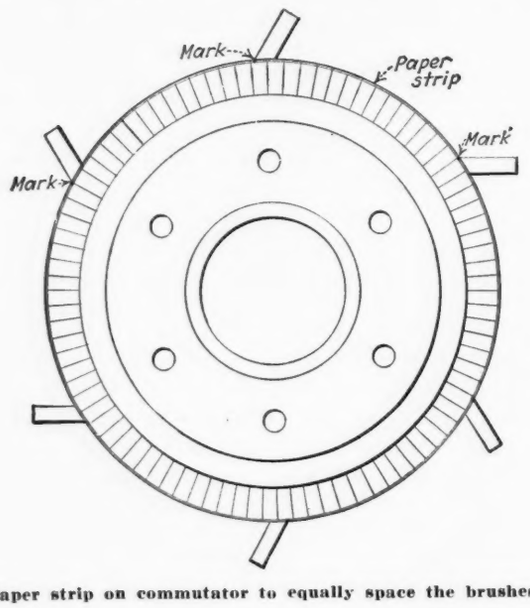


The control equipment consists of a speed-regulating panel and a motor-operated pressure regulator

. . . RIGHT OUT OF THE PLANT . . .

Spacing Brushes Correctly Around a Commutator

THERE are various methods of equally spacing the brushes around the commutator of direct-current machines, but the one that I have found most satisfactory is to use a narrow strip of white paper, such as used in an adding machine. The paper is placed around the commutator and cut to the exact circumference. Then it is removed and marked off into as many equal



Paper strip on commutator to equally space the brushes

parts as there are sets of brushes. The paper is again placed around the commutator and the brush toes set to the lines, as in the figure.

This method assures equal spacing regardless of the number of sets of brushes. To make the brushes fit the commutator place a piece of sand paper under one brush at a time, with the smooth side of the paper on the commutator. Draw the paper back and forth until the brush makes a good fit. It may be necessary to check the spacing of the brushes again after they have been fitted.

M. G. McCULLOUGH.

San Algelo, Texas.

Using Heavy Fuel Oil in Solid-Injection Diesel Engines

THE LETTER of A. H. Wirz, on page 559 of the April 8 number, entitled "Using Heavy Fuel Oil in Solid-Injection Diesel Engines," is very instructive, and presents a good description of the layout of a Diesel engine power plant. However, I think a little additional information would have made the letter even more interesting and I should like to ask, through the columns of *Power*, the following questions:

1. Was an air filter installed in the air intake line?
2. Was an air filter and a fuel-oil filter (centrifuge or other system of fuel oil purifying) provided for the near-by air-injection engine mentioned?
3. Was the De LaVergne engine operated as an isolated plant, or did it operate in parallel with other units?
4. What was the load-factor and average fuel rate per kilowatt-hour for the De LaVergne engine, and what number of hours per day and days per week did it operate?
5. What was the operating method of the fuel-oil system between the main storage tanks and the engine? To explain the meaning of the last question, it was said that there is a 100-gal. service tank mounted on the engine room wall. This would hold, roughly, two hours' supply of fuel at full load. Was this tank kept full continuously, or refilled at intervals, say every one or two hours? Was the pump controlled automatically or manually by the operator? Was the oil flow through the centrifuge continuous, or a tankful at a time?

I would greatly appreciate this additional information on the installation described by Mr. Wirz, and it would undoubtedly be helpful to other engineers.

Los Angeles, Calif. HOWARD LIVINGSTON.

Give the Engineer a Chance

RECENTLY there appeared in one of my engineering magazines the following advertisement:

> FOR SALE: One good Orsat gas analyzer, in good condition, owner has no further use for same, will sell cheap. Engineer P.D.Q. Power Co.

As the plant mentioned was on my route and as I had not been there for at least three months, I dropped in to see how things were going and the reasons for the "ad." I was surprised at the change in the plant. No longer the snap and pep that was once there. In place of the usual smooth-running and efficient plant, it was one of hurry and rush. The "chief" could only stop a minute and shake hands, explaining that he was busy. I was puzzled at this. Running around with him I managed to get the story.

First, the owners had cut down his forces to the point

where he was "chief cook and bottle washer" of the outfit. He was forced to stand the "watch" in the engine room. No oilers, no wipers—only one engineer and a fireman on each watch. A look over the plant showed the folly of this action on the part of the management. Boiler fronts and casings showed signs of neglect. Pumps and engines, turbines and other machinery were covered with dirt and dust. Steam was leaking here and there, water and air were hissing around rods and at joints in lines. And on top of all of this the engineer informed me that the "boss" had asked him if they could not cut the force some more.

As my business was partly with the manager I called on him at the office. During the conversation he asked me if I had been around to the plant. Upon telling him that I just had come from there he launched into a statement of the saving being made since he had put in the present policy of "economy," saying that they were saving 50 per cent on the labor of the plant, etc. Over in one corner of the office, on a table, was a stack of recent issues of *Power*. I went over and picked out the Sept. 17, 1929, number and opened it up at Mr. Low's foreword, "Give the Engineer a Chance," and handed it to him. He read it and asked, "Well, don't we give him a chance? Isn't he doing what he wants to do and getting along all right?"

This was too much for me, so I bade him good-bye and left. Surely "They have eyes to see and see not, ears to hear and hear not." THOMAS M. STREET.

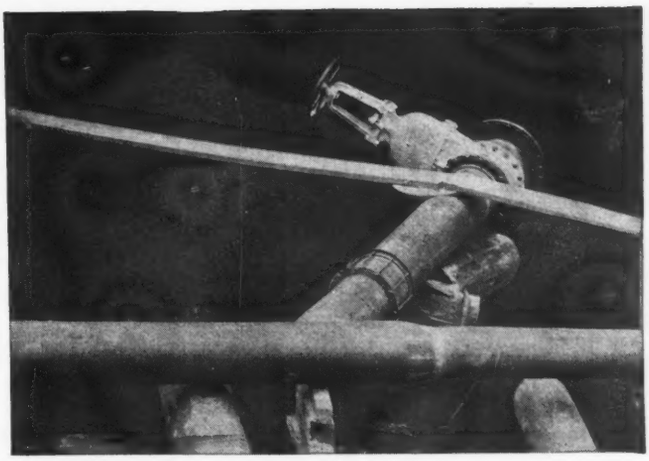
Wilkes-Barre, Pa.

Practical Notes on Piping Installation

WHEN any large amount of piping is to be installed, considerable saving can be effected by a little planning before the work is turned over to the pipe-fitting department. In larger sizes of piping, say 4 in. and over, welding can be substituted for cast-iron fittings. Two 45-deg. welds will make an efficient and practical turn. Also, in some of the smaller runs of piping, welds may be used; but it should be borne in mind that sufficient unions must be used to permit of pulling any separate piece of pipe or valve out of the line. There are fittings available made from seamless pipe in the form of bends in both 45- and 90-deg. angle patterns. As far as the cost is concerned, when two welds, either in the line, or to a steel flange, are considered, there is not much to be gained by the use of these bends; but in an installation where there is an objection to cast-iron fittings, bends are most useful. When they are properly welded in a line they make a neat-appearing job, and by using two 90-deg. turns a short radius return bend is obtained.

Where there is a long run of pipe of a larger size, the plain-end pipe with welded joints will give a considerable saving over pipe that has to be cut and threaded. Where cast-iron pipe or flanges are not permissible, steel welded hub flanges are usually resorted to. These are of forged-steel with a short beveled hub, and come in various drillings, one series corresponding to standard and another to extra-heavy drilling.

Where other than standard pipe is in use, such as casing, light-weight pipe and "henskin" (a steel flange) can be obtained that is bored to fit the casing and is suitable for welding on to it. These flanges are widely



Angle connection and reducer made by welding

employed where it is necessary to connect light-weight pipe to standard valves and fittings.

Where there is a large amount of light-weight pipe in a system it is a good plan to save short lengths and periodically send them to the welding plant or source of supply and have them welded up ready for use.

The Vanstone, or loose-ring, flange needs no introduction. This type is also available with a small hub, or welding lip, so that the whole can be attached to off-standard pipe.

Where two different diameters of pipe are to be joined together, in the smaller sizes, bushings, especially on high pressures, are not recommended. It is much better to use a bell reducer; better still, a swedged nipple. Many of the large oil companies prohibit the use of bushings, on the ground that if employed for low pressures they may inadvertently be put on high-pressure lines.

Although the application of reducing flanges is general, if space allows it is better to use a swedged nipple and two flanges. In large pipe a neat swedge may be made by slotting back the larger pipe for about three diameters with a torch, then heating the remaining sections and bending them in until they assume the diameter of the smaller pipe, when they are welded together and then around the circumference on to the smaller pipe, as shown in the accompanying illustration.

Long Beach, Calif. M. C. COCKSHOTT.

Across-the-Line Starting of Squirrel-Cage Motors

IN LINE with an editorial appearing in the March 11 number it has been proved beyond doubt that the old method of starting induction and synchronous motors was brought about more by apprehension than by effect, at least in so far as large industrial plants were concerned.

Those responsible for making rules and regulations regarding the starting of motors probably had in mind the safeguarding of the small consumer, but the fact remains that the rules so constituted a decade ago were the cause of high maintenance costs to the power user. The manufacturers of motors knew at that time that their squirrel-cage motors would stand across-the-line starting, but a rule is a rule, and it was necessary that they change their equipment because the rule could not

be changed without committing those responsible for the rule.

The following incidents are here quoted to show that it was probably a case of being more scared than hurt. In 1921 I installed a 35-hp. standard squirrel-cage induction motor on an application requiring three times normal current at starting, with three-quarters normal current when running. The starter coils were roasted the second time the motor was started, and the contacts were burned so badly that they required filing. After the compensator coils had been replaced three times it was decided to start the motor by means of a clutch. A 90-hp. clutch was installed, and was destroyed the third time the motor was started. The next expedient was the removal of all compensator parts with the exception of the running contacts, and the overload and no-voltage relays. The motor has been started on full voltage for nine years, the contacts have not been renewed, and the motor is in good condition.

A 60-hp. standard squirrel-cage motor driving a conveyor took 2½ times normal starting current from the line and was started by a compensator. This motor was later equipped with an across-the-line magnetic switch controlled from start and stop buttons, owing to the trouble and lost time with the compensator. The motor is started on an average of 200 times every 24 hr., but it has had no attention except oiling and an occasional cleaning in the last four years.

There are few applications where full-voltage starting of squirrel-cage induction motors is detrimental to the drive if the application is properly motored. Where heavy strains to the equipment are encountered, wound-rotor or synchronous motors should be used.

H. E. STAFFORD,
Port Arthur, Ontario. *Electrical Engineer,*
Provincial Paper Co., Ltd.

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I AM INTERESTED in the discussions on starting squirrel-cage motors by connecting them directly across-the-line. The charts show our experience. We have a 60-hp., 2,300-volt, 3-phase motor of this type direct connected to a centrifugal boiler-feed pump. There are also two 75-hp., 2,300-volt, 3-phase motors of the slip-ring type with automatic starters. The 60-hp. motor operates at 3,600 r.p.m., while the 75-hp. motors run 1,800 r.p.m.

On the day these charts were taken the 1,500-kw. turbine was operating. It will be seen from Fig. 1 that it had only about a quarter load. The 60-hp. motor was started six times, as indicated at *A*, and then thrown off as soon as it picked up the load. The 75-hp. motor was then started six times, as shown at *B*. At *C* this motor was put into service and left on the line. The load chart, Fig. 1, was taken at the plant, the voltage chart, Fig. 2, was taken at the office, over a mile away and on a different circuit.

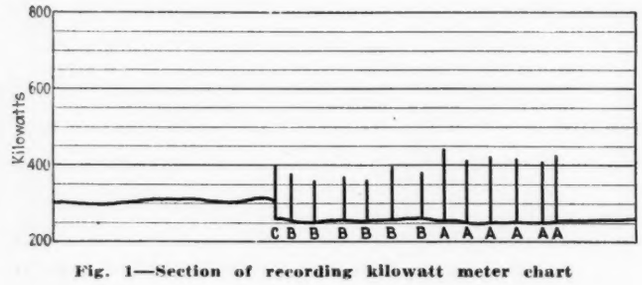


Fig. 1—Section of recording kilowatt meter chart

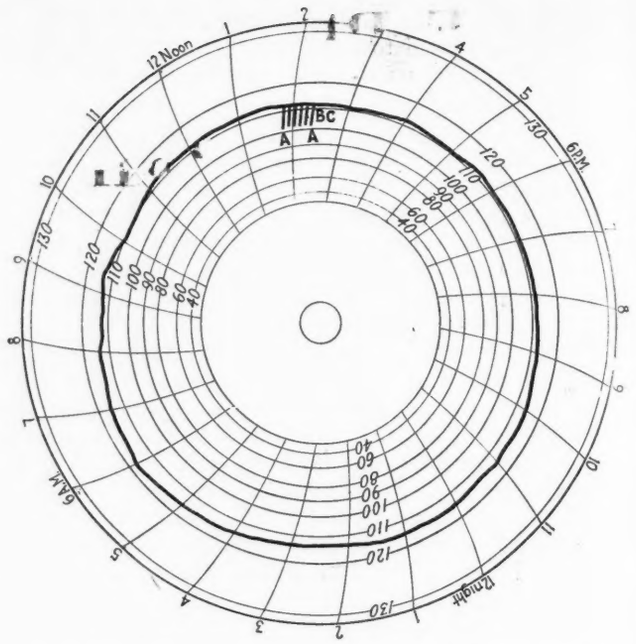


Fig. 2—Chart taken from the recording voltmeter on the same day Fig. 1 was taken

There was quite a voltage disturbance when the 60-hp. motor was started, and none with the 75-hp. motor. Because of this condition we do not start the 60-hp. motor during the lighting period, unless it is necessary in an emergency.

A. W. KIRBY,
Marshall, Mo. *Manager,* Municipal Utilities.

Accident to Turbine Blower Through Reversal of Rotation

THE comments of B. F. Powell in the May 6 number on an "Accident to Turbine Blower Through Reversal of "Rotation" are of interest and appear to be sound logic. However, I am of the opinion that Mr. Powell did not analyze conditions completely. His statement that it is impossible for the driven machine to exceed the speed of the driver is, in my opinion, erroneous. Is it not possible that temperature plays an important part?

Assuming that the driver is taking air in at the suction at atmospheric pressure and 60 deg. temperature and is delivering it at 10 lb. and 200 deg., at 3,600 r.p.m. Then we have the driven machine taking air in through the discharge line at an initial temperature of 200 deg. While the machine is starting to move, the air is rushing through the impeller in the reverse direction with a great drop in pressure, and as the machine increases its speed the difference in pressure becomes less due to the centrifugal force endeavoring to reverse the flow of air.

When the speed of the driven machine has approached the speed of the driver the temperature of the air in the driven machine should be somewhat in excess of that in the driver, due to the churning action. Furthermore, as the specific gravity of the air in the driven machine is less, it would require a greater velocity to build up its pressure to equal the pressure in the driving machine. Therefore, as long as a difference in pressure exists, velocity will continue to increase, and, in my opinion, may reach dangerous proportions.

Indianapolis, Ind. ARNO G. SIEFKER.

SLIDE RULE Simplifies ORIFICE-FLOW Calculations*

By H. G. HYLAND
Roessler & Hasslacher Chemical Co.
Niagara Falls, N. Y.

TO FACILITATE calculations of orifice diameters and in the design of the scale where extreme accuracy is not required, a flow-meter slide rule has been designed which takes care of practically all of the variables entering into the calculations. In a test made to determine the accuracy of the slide rule the results obtained with it checked within 1 per cent, on about 25 steam, gas, and liquid calculations made by long hand using a reliable flow-meter company's data. This difference appears negligible when it is realized that orifice coefficients as given by different authorities vary as much as 3 or 4 per cent.

Equations 2, 3 and 4 are derived from the general orifice-flow equations

$$Q = C \frac{\pi}{4} d^2 \sqrt{2gh} \qquad (1)$$

where C = Orifice coefficient.[1]
Q = Flow in cubic feet per second at the down-stream density.
h = Differential head in feet of the fluid flowing, based on the down-stream density.
d = Diameter of orifice in feet.
g = Acceleration of gravity in feet per second per second.

Since Spitzglass determined orifice coefficients for 3- to 12-in. pipes, it was necessary to extrapolate the curves to include the smaller-sized pipes. Values of the orifice coefficients found by Spitzglass are plotted in Fig. 1. Dotted sections of the lines are extrapolations. If it is desired to rely only upon Spitzglass data, a 3-in. pipe may be inserted for a sufficient length in a smaller line and the orifice plate placed in it. To prevent error due to turbulence of the stream, the 3-in. pipe should extend at least 20 times its diameter upstream and 10 diameters downstream, or straightening vanes should be employed. The upstream tap should be between 0.75 and 2 pipe diameters from the orifice, and the downstream tap should be at the vena contracta. The position of the vena contracta is different for each orifice ratio, but if the low-pressure tap is placed 0.35 pipe diameters downstream from the orifice it will be so close to the vena contracta for all orifice ratios ($\frac{d^2}{D^2}$ where D = inside diameter of pipe) up to 0.60 that the error will be less than one-half of 1 per cent.

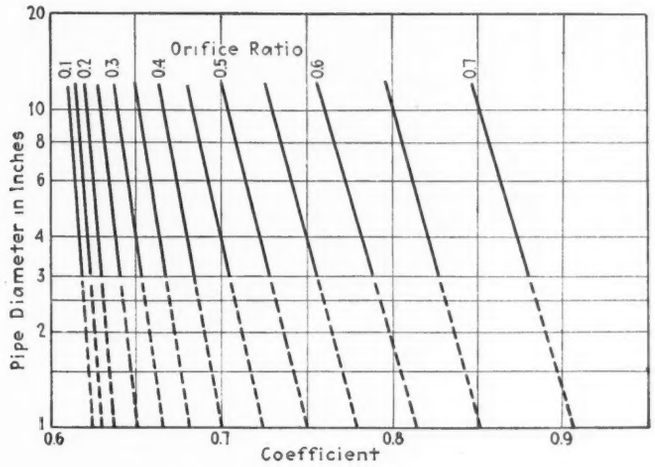


Fig. 1 — Orifice coefficients for pipe sizes up to 12-in. diameter[3]

Design of the slide rule for gas-flow calculations is based on the equation

$$Q = C_1 C_d^2 \sqrt{\frac{HPT_s}{P_s \rho_s T}} = K \sqrt{\frac{HPT_s}{P_s \rho_s T}} \qquad (2)$$

where d = Orifice diameter in inches.
C = Orifice coefficient.
H = Differential pressure in inches of mercury.
P = Absolute pressure in pounds per square inch at the downstream tap. (The slide rule is graduated in gage pressure for convenience.)
P_s = Standard absolute pressure.[2]
T = Temperature at downstream tap in degrees Fahrenheit absolute. (The slide rule is graduated in degrees Fahrenheit for convenience.)
T_s = Standard temperature in degrees Fahrenheit.[2]
ρ_s = Density of gas flowing in pounds per cubic foot at standard temperature and pressure.
Q = Gas flow in cubic feet per minute measured at standard conditions.
C_1 = A constant.
K = A constant for any given flow meter.

Strictly speaking, the value of P in Equation 2, and hence in the operation of the slide rule, should be the pressure at the downstream tap. Since the differential is usually a small per cent of the initial absolute pressure, the pressure at the upstream tap may be used without introducing appreciable error in most cases; hence only one setting of the slide rule will be required. If the differential is a large per cent of the initial pressure it will be necessary to set the rule for each increment of flow.

Equation 2 can be solved on a slide rule having two fixed full-size logarithmic scales graduated in values of K and Q and four sliding half-size logarithmic scales graduated in values of H, ρ, P and T whose positions relative to each other are fixed. Such a slide rule is shown in Fig. 2.

The top part is designed so that values of K may be found graphically without the use of separate curves and calculations. The nominal standard pipe sizes, in inches, are represented by the long curved lines, and the orifice diameters, in inches, are represented by the diagonal straight lines. The value of K is represented by a vertical line through the point of intersection of the orifice and pipe curves. Numerical values of K are not shown, because they are of no interest.

The design of the slide rule for stream-flow calculations is based on the following equation

$$Q = K \sqrt{\frac{HM}{VM_1}} \qquad (3)$$

*All rights reserved by the author.

[1]Given by Spitzglass in the *Transactions* of the A.S.M.E. 44, p. 919, 1922.

[2]Any standard may be used for either temperature or pressure so long as the corresponding value of the density ρ_s is based on the same standard conditions.

[3]H. G. Schnetzler, vol. 19, page 1027, *Industrial and Engineering Chemistry*.

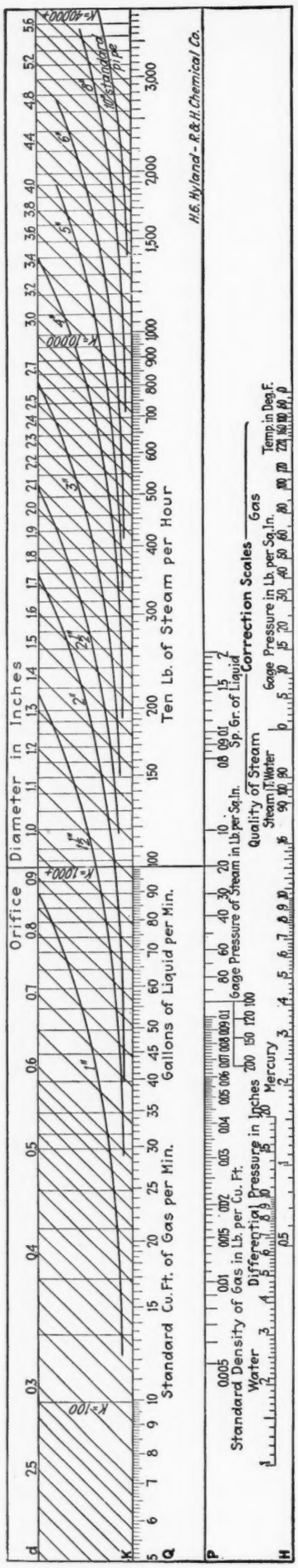

Orifice Diameter in Inches
Standard Cu. Ft. of Gas per Min.
Gallons of Liquid per Min.
Ten Lb. of Steam per Hour
Standard Density of Gas in Lb. per Cu. Ft.
Differential Pressure in Inches Water
Mercury
Gage Pressure of Steam in Lb. per Sq. In.
Sp. Gr. of Liquid
Correction Scales — Gas
Quality of Steam
Steam
T. Water
Gage Pressure in Lb. per Sq. In.
Temp. in Deg. F.
H.B. Nyland - P. & H. Chemical Co.

Fig. 2—Slide rule for thin-plate orifice flow-meter calculations with the low-pressure tap at the vena contracta

Where Q = Steam flow in ten pounds per hour.

H = Differential pressure in inches of mercury under water (equivalent sp.gr. = 12.54.)

V = [1]Specific volume of saturated steam in cubic feet per pound at the downstream tap pressure.

M = [1]Correction factor for wet steam.

M_1 = Correction factor for saturated steam.

K = A constant for any given flow meter (In order to use the same K and H scales for gas calculations and allow for the different units, the V and H scales were shifted relative to each other. Hence the H scale really reads in inches of mercury under water instead of in inches of mercury as for gases.)

The design of the slide rule for liquid-flow calculations is based on the equation

$$Q = K\sqrt{\frac{H}{G}}$$

Where Q = Liquid flow in gallons per minute.

H = Differential pressure in inches of mercury under water (equivalent sp.gr. = 12.54).

G = Specific gravity of the liquid flowing referred to water (density of water used equals 62.4 lb. per cu.ft.).

K = A constant for any given flow meter. (In order to use the same K and H scales as for gas calculations and allow for the different units, the G and H scales were shifted relative to each other. Hence the H scale reads in inches of mercury under water instead of inches of mercury, as for gases.)

Equations 2, 3 and 4 are each incorporated in the slide rule shown in Fig. 2.

Although the slide rule may be used without making a special base for it, it is desirable to make a cardboard or, preferably, wooden base to which the three sections may be glued. A wooden base designed as in Fig. 3 with a celluloid runner, Fig. 4, has been found to work satisfactorily. After the scales are glued to the base, they may be given a coat transparent white shellac.

Cut the slide rule into its three sections. Glue the section containing the P and H scales to the movable slide A, Fig. 3. Glue the widest section containing the diagonal lines and curves to the stationary member C, and the remaining section, containing the Q scale, to the stationary member B. Both B and C are fixed to the member D. Be sure that the heavy vertical line through the $Q = 100$ point of the narrow stationary section is in line with the corresponding line marked $K = 1{,}000 +$ of the wide stationary section.

Although it is not necessary to have a runner, its use considerably facilitates the operation of the slide rule. It is easily made by cold bending a small piece of celluloid into the shape shown in Fig. 4 and then scratching a hair line on it with a sharp round-pointed instrument. The operating instructions are written for use with a runner; but they may be followed without its use by observing the positions the runner would assume if it were used.

Operating Instructions

I.—To Calculate Orifice Diameter:

A. *Liquid:*

1. Set the runner to maximum flow in gallons per min. on the Q scale.
2. Set the maximum deflection in inches of mercury on H scale to runner.
3. Set the runner to specific gravity of liquid flowing, on P scale.
4. At the intersection of the runner with the pipe-sized curve, read the orifice diameter from the 45-deg. lines.

B. *Steam:*

1. Set the runner to maximum flow in 10 lb. per hour on the Q scale.
2. Set the maximum deflection in inches of mercury on the H scale to runner.
3. Set the runner to 100 on the H steam-quality scale.
4. Set the actual operating quality on H scale to runner. If the meter is to read in flow of total pounds of dry steam and water use quality scale marked "T. Water." If only the actual dry steam flowing is desired, use the scale marked "Steam."
5. Set the runner to gage pressure of steam on the P scale.
6. At the intersection of the runner with the pipe size curve read the orifice diameter from the 45-deg. lines.

C. *Gas or Vapor Equation:*

$$Q = CC_1 d^2\sqrt{\frac{HPT_s}{\rho_s P_s T}} = K\sqrt{\frac{HPT_s}{\rho_s P_s T}}$$

1. Set the runner to maximum flow in cubic feet per minute on the Q scale.
2. Set the maximum deflection in inches of water on the H scale to runner.
3. Set the runner to standard temperature on the H scale.
4. Set the actual operating temperature on the H scale to runner.
5. Set the runner to standard gage pressure on the H scale.
6. Set the actual operating gage

[1]Note: For convenience the V scale is graduated in values of gage pressure of steam, and the M scale in values of steam quality.

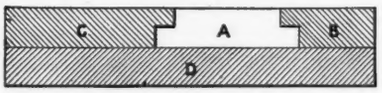


Fig. 3—Cross-section of the slide rule

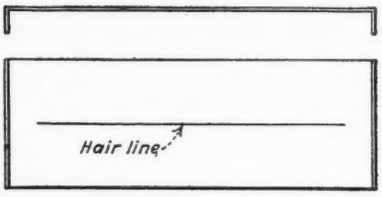


Fig. 4—Runner for the slid rule

pressure on the H scale to runner.

7. Set the runner to density at standard conditions on the P scale.
8. At the intersection of the runner with the pipe-size curve read the orifice diameter from the 45-deg. lines.

II.—To Calculate Flow:

To calculate the flow for a given differential pressure, or, vice versa, when the orifice diameter is known, reverse the foregoing procedure.

III.—To Design a Scale (compressibility of the fluid is neglected):

1. Set the maximum differential pressure on the H scale opposite the maximum flow on the Q scale. Any other corresponding values of H and Q may be used if known.
2. Opposite any flow in the Q scale obtain the corresponding gage fluid deflection on the H scale.
3. Mark off a zero point at the bottom of the scale, measure up H inches, make a mark and label with the corresponding value of Q. Use as small increments of flow as desired.

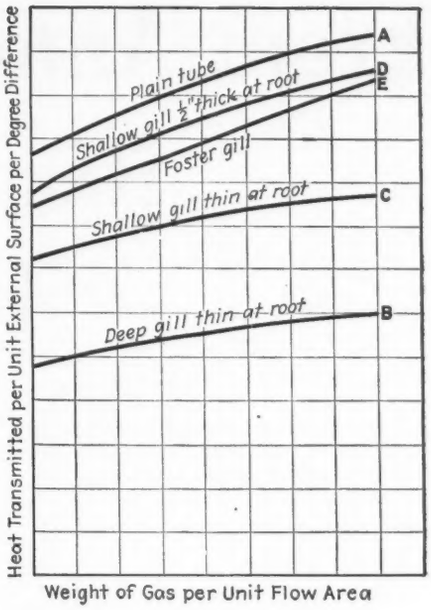


Fig. 2—Heat transfer rates with types of tubes shown in Fig. 1

▼ ▼ ▼

Effect of Economizer Surface on Heat Transmission

Some interesting thoughts on the economic shape, location, and amount of economizer surface were contained in a paper "Heat-Transmission Problems" in the Nov. 22, 1929, number of *Mechanical World and Engineering Record*, Manchester, England. By G. E. Tausley and O. Kubalek. The following digest covers the points of greatest interest to the readers of *Power*.

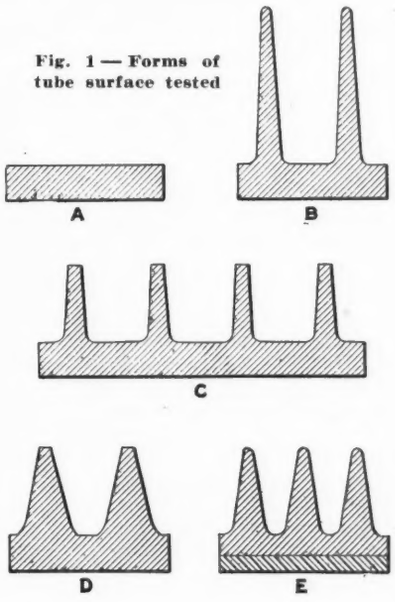
WHERE water is heated by gas, as in boilers and economizers, the metal surface in contact with the gas has approximately the same temperature as the water, and the total heat transfer rate is determined almost entirely by conditions on this surface.

In the early days of economizers the heat transmitted per square foot of surface per degree difference of temperature between gas and water seldom exceeded 3 b.t.u. per hour. By speeding up the gas velocity, and thus increasing heat transfer, the economizer investment may be greatly reduced.

Notwithstanding certain advantages of the smooth-tube economizer, extended or gilled surfaces were adopted after the World War on the Continent in connection with economizer practice, the main consideration at the time being capital outlay. The type of gilled surface adopted appeared to be capable of considerable improvement, not only from the viewpoint of cleaning, but for other reasons. It occurred to the authors that between the smooth type and the tube having gills of two inches and more in depth and of varying thickness, there should be a form of gill which would give maximum efficiency. Eventually, after a series of progressive experiments, a form of surface was decided upon which transmitted practically the same amount of heat per square foot of extended service as the plain tube.

To avoid the uncertain element due to dirt in flue gases, air was used as a heating medium in these tests. This was supplied by a variable-speed fan to an air heater direct conected to town gas. The water was supplied by a variable-speed pump from two large measuring tanks, the quantities being also under control, and the volume of water being heated remained constant for each series.

Fig. 1 — Forms of tube surface tested



The forms of tube gills tested are shown in Fig. 1, and the results obtained in these tests in Fig. 2.

It will be noted that the long gill with narrow base does not give a very effective use of the surface.

The general conclusion arrived at may be summarized as follows:

1. The heat transfer per square foot was naturally highest with the plain tube, and lowest with the deep gill.
2. The outer periphery of the deep gill was much less effective than the inner periphery.
3. A reduction of 50 per cent in heating surface by turning off the outer periphery of the gill resulted in a loss per tube of only 10 per cent of duty.
4. To obtain maximum efficiency there should be a definite minimum thickness of gill at the root relative to its depth.
5. The relation between thickness and depth is a variable depending upon the maximum velocity of the gases passing across the tubes, a deeper gill being more suitable in slow-moving than in high-velocity gases.
6. The results from a properly designed gill cast on a tube will be approximately equal to the results from a plain tube per square foot of heating surface.

As a result of these experiments it was decided to adopt a section of tube similar to D, Fig. 1, a form already widely used in economizer construction.

The type of construction shown at E, Fig 1, consisting of cast-iron gilled sleeves shrunk on a steel inner tube, is now well known. The space occupied by a steel tube economizer of this type is less than for a plain tube.

From Among Readers' Problems

Conducted by
L. H. MORRISON

FLYWHEEL ON AIR COMPRESSORS—*What are the effects of inadequate and of excessive flywheel effect when air compressors are driven by synchronous motors?* R.E.MCB.

When the flywheel does not have sufficient weight the motor is likely to hunt and cause a surging of the power input to the machine. This surging may reach proportions that will interfere with other equipment on the system. The increased oscillations of the rotor may result in sufficient current's flowing in the pole-face winding to produce overheating.

Excessive flywheel weight will make the machine more difficult for the motor to accelerate and pull into step during starting. The crankshaft and bearing will have to be unnecessarily large, and the cost of the machine will be increased.

HIGH-COMPRESSION IN COMPOUND ENGINE—*We have a 150-kw. compound balanced-valve steam engine which shows loops on the compression line of the indicator diagram from both cylinders. It has been recommended that an offset key be used to make compression occur later to avoid the high terminal pressure. Is this advisable?*

When pulling 75 kw. the engine has a steam consumption greater than our 75-kw. single cylinder engine has when carrying the same load. Does this mean the engine is in bad condition. M.Z.R.

I strongly recommend against the idea of inserting an offset key in the shaft, because this will tend to make all of the valve events later. To carry any given load, it is necessary to have the cutoff occur at a definite point. Therefore, if you insert the offset key at any given engine speed the cutoff will be later than it was before, which means that the engine will speed up and the governor will retard so that the cutoff would come back to the original point, and your compression would also return to the same position as at present. This shows that there is no advantage in the offset key.

You should cut away the exhaust lap of both the high-pressure and the low-pressure valves, provided both cylinders give loops. This will make the compression occur a little later, and, incidentally, will make the release occur a little earlier. Early release with a compound engine, especially since it is exhausting against 4- or 5-lb. back pressure, should not be very objectionable.

The reason for the loops lies in the fact that the engine is operating against a back pressure of 4 or 5 lb., and the amount of clearance in the cylinder end is such that the steam trapped in this space is compressed above the initial pressure. If the back pressure were atmospheric, the loops would probably disappear. Only a slight amount of the exhaust lap should be removed at a time, until the indicator diagram shows that the loops have disappeared.

In regard to the fact that the compound engine shows a higher steam consumption for a given load than does the single-valve engine when carrying the same load: That is due to the fact that the compound engine is operating at about half load, and naturally its steam consumption is lower than it would be at full load, and apparently in this case the steam consumption at half load is somewhat higher than the steam consumption of the single-valve engine at full load.

PREVIOUS QUESTION

Discussed by Readers

THE QUESTION

WE HAVE recently purchased an evaporator, second-hand, suitable for an operating pressure of 75 lb. As our boiler pressure is 250 lb., it will necessitate the use of a reducing valve. Our master mechanic suggests installing the evaporator adjacent to one of the main turbine units and bleeding steam at the 75-lb. stage and discharging the vapor into one of the lower stages of the turbine instead of installing a special condenser for this purpose. E.P.S.

FROM the standpoint of evaporator capacity, the proposed interstage installation of the evaporator might prove satisfactory, since with decreasing turbine load there is a drop in steam pressure and temperature at both bleeder stages.

Taking the quoted pressures to be gage, the following temperature differences between stages at "full" and "light" loads are obtained:

	Turbine Load	
	Full	Light
High-stage pressure, lb. abs.	65	35
Low-stage pressure, lb. abs.	15	9.75
High-stage saturation temperature, deg. F.	298	259
Low-stage saturation temperature, deg. F.	213	192
Temperature difference, deg. F.	85	67

Since the capacity of an evaporator is approximately proportional to the difference between the saturation temperatures of the supply steam and the vapor, it is seen that at light load the evaporator would have a capacity of about $\frac{67}{85}$, or 79 per cent of its capacity at full turbine load. Whether this would constitute a serious reduction depends upon the relation between the evaporator capacity and the make-up requirements of the plant, and upon the average load carried on the turbine.

It is imperative that the evaporator have a high-water alarm. It is assumed that the evaporator is equipped with some sort of automatic float-controlled feeder, to maintain a steady water level in the evaporator. However, if this feeder were to get out of order and allow the evaporator to flood, water would flow through the vapor line to the turbine. Hence the need for a high-water alarm.

It would be desirable to check the size of the vapor outlet connection on the evaporator in relation to the volume of vapor it must handle at the lowest anticipated vapor pressure. Since the evaporator was purchased second-hand, it might be that the vapor connection is too small to pass, at 10 in. vacuum, the full amount of vapor the evaporator is capable of generating. To avoid excessive pressure drop, the vapor velocity should not run higher than from 8,000 to 10,000 ft. per minute. Also, it is desirable for the same reason to install the

evaporator close to the turbine, thus permitting the use of short steam and vapor lines.

The proposed turbine bleed points seem to be well chosen, since with fresh-water feed an evaporator should not be operated under a temperature difference greater than 80 to 85 deg. F. Allowing for piping losses, it is improbable that the full-load temperature head at the evaporator would exceed 80 deg. If the feed were sea water, excessive foaming and priming would probably occur at temperature heads greater than 60 deg. F Hence, the proposed extraction points would not be satisfactory for sea-water feed.

Before planning such an installation it would be well to consult the turbine manufacturer in regard to the reduction in turbine capacity to be expected; also, as to whether the bleeder connections are large enough to handle the proposed quantities of steam and vapor.

LAWRENCE WASHINGTON.
Palo Alto, Calif.

AN EVAPORATOR is essentially a steam-operated boiler for distilling raw water to produce pure vapor. The vapor generated may be utilized in its present state or may be condensed to pure distillate.

Operation of an evaporator on bleed steam is of advantage, as the steam required has already been put to work from the throttle to the bleed point. With the evaporator vapor returned to the turbine, approximately the only loss of work of the steam is between the bleed and returned stages. It is likely that the vapor produced will be very nearly as much as the steam bled.

With a reducing valve, the work in the steam required is lost from the boiler pressure to the evaporator-heating-element working pressure. As can readily be understood, the primary object in developing steam is to obtain the maximum energy per pound of steam generated; therefore, bleed steam should be used, if suitable for the conditions, in preference to reduced pressure boiler steam.

The arrangement as suggested is ideal for an evaporator, providing operating conditions conform to the requirements for which the evaporator was designed.

Referring to the first plan, the evaporator vapor pressure to process may be controlled by a regulating valve in the steam line to the evaporator, with the vapor pressure used as the controlling medium.

A high-heat-level condenser may be defined as one in the boiler-feed line whereby the latent heat of the evaporator vapor is transferred to the boiler feed water, thereby allowing higher-temperature boiler feed.

A raw-water condenser is one in which the latent heat of the evaporator vapor is transferred to the raw water, and may be lost if the raw water has no further use.

ROBERT W. MUNRO,
The Griscom-Russell Company.
New York City.

IF THE main turbine is provided with a bleed connection so that a suitable amount of steam may be bled at a pressure of 40 to 50 lb. gage during a large portion of the time, this is an ideal way to obtain steam for evaporators. Ample soft water storage should be supplied, so that the evaporator may run along and vary its rating with the variations of turbine load. A check valve should be installed in the bleed line near the turbine to prevent flow back into the turbine.

Discharge of the evaporator vapor into a lower stage of the turbine would not be advisable without safeguards to prevent water going into the turbine. Also, the possibility of sufficient vapor's being supplied to overspeed the turbine in case of loss of load should be considered. The turbine manufacturer should be consulted before attempting this method of discharging the vapor.

The simplest plan to dispose of the vapor would be into the feed water heating system, if conditions permit. If the evaporators have some capacity in excess of ordinary requirements, it would not often be necessary to operate with a wide range between steam and vapor pressures. For unusual conditions and when the turbine is shut down, live steam controlled by a globe valve could be used.

C. A. TOMPKINSON.
Parson, Kan.

THE IDEA of extracting steam from the main unit is correct. Steam through a reducing valve should be used only for emergency operation of the evaporator, as it entails a waste of available energy.

However, the discharge of vapor into the lower stages of the turbine has a number of disadvantages:

It admits extremely wet steam to the lower stages, lowers turbine efficiency in those stages and increases blade wear.

Depending on the size of the turbine and output of the evaporator, the turbine exhaust pressure will be increased to some extent, raising its steam rate.

Evaporated make-up contains much air, and will considerably increase the oxygen content of the turbine condensate, since there is no way of venting.

The great difference between the evaporator pressure, of 50 to 20 lb., and the turbine lower stage pressure, atmospheric to 10 in. vacuum, will facilitate priming of the evaporator, with consequent contamination of the turbine condensate.

Emergency operation of the evaporator, with the turbine shut down, is not possible.

A storage tank, with increased chances of aërating the turbine condensate, is required between the hot-well pump and the boiler-feed pump.

Points in favor of the scheme are the cost of the evaporator condenser and a slight loss in turbine capacity through use of the evaporator condenser.

The best layout would be the evaporator condenser, using extracted steam for regular operation, and a hand valve for reducing header steam for emergency operation.

R. H. SOGARD.
Topeka, Kan.

IT IS most economical and practical to bleed steam from a turbine to supply an evaporator. The steam should be allowed to give off its latent heat and condense in the evaporator. It should then be trapped back to the feed-water heating system. Variations in the initial conditions of the bled steam due to varying load on the turbine will merely call for compensation of the amount of heat transferred to the raw water. That can be accomplished by adjusting the flow of steam through the evaporator by hand control.

HAROLD A. BAUMAN.
Forest Hills, N. Y.

IT WOULD not be good practice to discharge the vapor from the evaporator, into one of the lower-pressure stages of the turbine because of the oxygen that would be contained in this vapor. Oxygen would cause corrosion of the turbine blading, especially at the temperatures that would prevail and in the presence of moisture as found in the lower stages. Corrosion would be particularly serious if the blades were of steel.

The best arrangement would be to have a special condenser for the evaporator and use condensate for cooling water, thus recovering the heat from the vapor. The vapor could be piped directly to the main condenser, but care should be taken that there is sufficient air-pump capacity to handle the entrained air.

Bleeding steam from the turbine at 20 to 50 lb. is more economical than using live steam through a reducing valve. However, it should be borne in mind that the capacity of the evaporator at 20 to 50 lb. is considerably less than it would be at 75 lb. A good check valve should be provided between the turbine and the evaporator to prevent any danger of water backing up into the turbine.

WESTON A. BROWN.
Philo, Ohio. Ohio Power Co.

A Question for Our Readers

OUR feed water lines are of the loop, or two header, design, supplied by a duplex steam-driven pump. If we feed through one header severe water-hammer occurs, which is absent when the second header is used. What is the cause?

F. R.

Suitable answers from readers will be paid for and published in the July 29 number

Practical and Theoretical Problems
Discussed at Oil and Gas Power Meeting

Problems of high-speed engine design, both chemical and metallurgical were the subjects of several papers. Other practical papers dealt with plant design, combination steam and Diesel plants, and the comparative advantage of a steam central station serving transmission lines and isolated Diesel plants.

THE third National Conference of the A.S.M.E. Oil & Gas Power Division, held at Pennsylvania State College, June 12 to 14, attracted 300 engineers, an increase over previous conference attendance. The subject matter of the sixteen papers presented during the three days covered a wide range, special emphasis being placed on high-speed Diesel problems.

The opening session was devoted to three papers on oil spray research.

In his paper, "The Research of the National Advisory Committee for Aeronautics on Aircraft Diesels," Carlton Kemper discussed the influence of orifice shape upon the oil spray and pointed out that the coefficient of discharge is increased when the orifice edges are rounded. The ratio of orifice length to diameter is relatively unimportant. Several designs of combustion chambers were submitted. One of these, a pre-combustion design, gave 135 lb. i.m.e.p. at 1,500 r.p.m. and a fuel consumption of 0.4 lb. Although this design is assumed, usually, to be adaptable only to slow-speed engines, due to slowness of combustion, the author reported that he obtained a pressure rise of 1,080,000 lb. per square inch per second with it. A pancake type of combustion chamber was also tested, and it was reported that the performance permitted of speeds up to those required in aviation.

The work being carried on at Penn State was covered by Prof. P. H. Schweitzer in his paper "Factors in Nozzle Design." He recommended that orifice ratio of length to diameter should not exceed 4, and emphasized the desirability of rounded edges. Timing of cam-controlled spray valves is irregular due to the compression of the long needle valve; curves given revealed that while the valve roller actually followed the cam, the oil flow was distorted, starting late and ending early.

An interesting development at Penn State is the method used to discover the oil spray shape and penetration, which includes the use of staggered segments of blotting paper placed at varying distances from the spray. Weighing the paper after an oil injection enables one to plot the path of the spray.

In the third paper, "Pressure Fluctuation in a Common-Rail System," A. M. Rothrock, of Langley Field, presented the results of a study made on the characteristics of this system. He pointed out that the length of pipe from pump to needle valve is often such that the pressure waves cause the needle to lift a second time, resulting in dribbling. The author recommended that the tubing be at least four times the orifice diameter and that the tube length in inches equal twice the injection period in ten-thousandths of a second.

In the discussion Leo M. Griffiths, Los Angeles, declared that the engine tests were disappointing in that 135 lb. m.e.p. at 1,500 r.p.m. is not enough, showing that combustion is not correct, and felt that the first Langley Field engine of 10 years ago did better.

Oliver F. Allen voiced the opinion that high speed was to be the predominating characteristic of the future Diesel. Modern metallurgy permits of speeds and pressures far beyond those possible in the past.

At the Thursday afternoon session Wiley H. Butler presented a "Progress Report on Research in Diesel Fuel-Oil Specifications." This covered the activities of the A.S.M.E. Fuel Oil Research Committee. The committee is proceeding with work of supplying engine builders and users with an oil that seems to be one that is cheap and should be satisfactory. The several reports from those testing this oil indicate that it is not satisfactory for all types of engines. One engine builder is engaged in a series of tests on an oil whose viscosity and carbon residue is changed by various percentages of blending, which the committee hopes will be productive of much information.

The report of the A.S.M.E. Diesel Power Cost Committee attracted lengthy discussion, much of which indicated two or more schools of thinking. The report covered 36 plants for which complete returns had been obtained. The output of these plants totaled 134,766,761 kw.-hr., and most of them were those reported upon in 1929. The average fuel oil cost was 4.19 cents per gal., while lubricating oil had an average cost of 51.5 cents, with a range between 37.9 and 85.5 cents. The total installed horsepower of these plants was 57,995, about 2 per cent of the Diesel engines in the country. The average cost of repair and supplies was reported as 1,449 mills per kw.-hr.

In the discussion Julius Kuttner presented a chart in which the various engines tested in the report were classified by types. This revealed that two-stroke-cycle air-injection Diesels give the best performance. H. C. Thuerck expressed the opinion that the weighted average was not the best to use in establishing costs, and advocated the median value instead. E. W. Hammond, Worthington Pump & Machinery Corporation, pointed out that as the report carried many plants built several years ago, when engine costs were twice the present prices; and that overhead charges given in the report were far beyond those chargeable to new plants. Consequently, one investigating probable costs in a new plant should use the values in the table with caution. Edgar J. Kates stated that averages were of little benefit to a person examining power costs unless all local influences affecting costs were known.

READING of a paper on "The Gas Turbine and Supercharger," by Dr. C. A. Lorenzen, noted German engineer, received close attention from the audience. The author devoted most of his attention to the gas turbine and its possibility. Essentially, the machine consists of explosion chamber, blade wheels, and an air-compression device. The blades are hollow, and the centrifugal action draws air through the space, which holds the blade temperature within operating limits, and this air is forced through nozzles, where the velocity head is converted into a pressure head sufficient to enable the air introduction into the explosion chambers. Its efficiency, so the inventor claimed, will be as high as 32 per cent. Cost of the unit will be less than for a steam plant, but the space will be about the same, as the exhaust gas-air heat interchanger will be quite bulky.

THE FIRST paper of the Friday morning session was by E. W. Hammond, Worthington Pump & Machinery Corporation, on "Diesel Power Layout." The author dealt with proper design of the plant building and the placing of auxiliary equipment. He strongly disapproved the tendency to place pumps and other small machines along the plant walls, and recommended the addition of a small room or the construction of a basement.

To obtain the maximum efficiency from any Diesel plant it is necessary that the layout provide auxiliary equip-

ment of ample size and proper design to operate without trouble. A plant should have a spare pump for each service placed adjacent to those required.

A motor-driven duplicate air compressor for regular and stand-by service, when installed, should be placed adjacent to the gasoline-engine-driven unit. Either compressor should be capable of providing the starting air at the required pressure, usually 250 lb., and for the air-injection plant should be capable of pumping air to 700 lb. When restricted for room it is possible to charge high-pressure air bottles, which require a small space, and blow these down into a 250 lb. tank.

A lubricating-oil centrifuge, the speaker stated, should be provided for all trunk-piston and crosshead engines when carbon working past the rings can enter the crankcase. The centrifuge is best placed in the auxiliary room, and piping is required to take the oil from and return it to the engines. With one arrangement oil is bypassed from the engine-pressure system to the centrifuge, cleaned, and immediately returned to the engine sump tank. With the periodic cleaning plan all the oil from the main engine sump is pumped over to the lubricating-oil tank, placed adjacent to the centrifuge. After cleaning, the oil can be pumped back to the main engine sump tank.

The exhaust silencing system must be planned to eliminate back pressure, so as not to reduce the load-carrying capacity of the engine. To reduce back pressure a proper muffler and a pipe without bends should be installed; a long-radius bend pipe should be used when bends are necessary, since this offers much less resistance than the short-radius bend. When exhaust lines are necesarily long, larger pipe is required than for short ones.

Since filters remove dirt from the engine suction air, and by so doing reduce engine wear materially, they should be provided for the well-planned station. If the air suction is taken from the engine room interior, heating is very difficult; therefore the air filters should be located outside the building. Hoods are usually used to protect the filter cells from the elements.

THE SECOND PAPER, "Joint Use of Diesel and Steam Engines to Balance Heat and Power," by Edgar J. Kates, was a study of the advantages of using a Diesel engine to carry the power load when exhaust steam is not needed. Among other controversial points was the advocation of a steam and a Diesel engine coupled to a single generator. In the discussion, L. H. Morrison, of New York, associate editor of *Power*, pointed out the impracticability of such an arrangement and stressed the lack of flexibility. He did not agree that in such a plant the steam engine efficiency is of no great moment.

E. W. Hammond stated that no engine builder would accept an order for such an installation, for the long, rigid shaft would set up extensive vibration stresses. Prof. Harold C. Berry, Harvard Engineering School, pointed out that the steam accumulation, mentioned in the paper, was suitable only where large pressure variations and small load changes existed.

"Economics of Diesel Engines for Power Generation," by T. A. Burdick, chief engineer, General Water Works & Electric Corporation, was one of the outstanding papers, dealing as it did with the relative advantages of a large steam plant with a transmission line, and of a number of small Diesel plants. This study was based on the Texas-Louisiana Power Company's present system, and gave actual investment and operating cost. Surprisingly, total operating costs with three set-ups showed but little difference.

It was the author's conclusion that there is a definitely established field for Diesel plants where the capacity of the plant is small, where water and cooling conditions are unfavorable for condensing turbine operation, where the site is relatively inaccessible or where space is extremely limited.

IT IS of more interest, however, to compare the Diesel plant with other types of plants for situations where none of the above conditions exists, strictly on a basis of operating and investment cost. On such a basis and in cases where there is no cheaper fuel available than oil, it would appear that the Diesel plant is on par with any other type of plant, provided the engines used are of correct and satisfactory design and can be relied on for uninterrupted service when a proper maintenance schedule is followed. The success or failure of this type of prime mover, then, in the final analysis, depends on the manufacturers of the engines. Adequate engineering, suitable design, proper selection of materials, good workmanship, and a willingness to stand behind their product in operation as well as in sales promotion should establish a high and important position for Diesel engines in the power field.

FRIDAY AFTERNOON was taken up by a picnic in the mountains and a golf tournament. In the evening the annual banquet was held, at which various entertainment features were presented.

Saturday morning C. R. Alden, Excello Aircraft & Tool Corporation, presented a paper on "Nitride Hardening of Alloy Steels for Diesel Engine Use." The advantage of nitriding is that an extremely hard surface is given to the steel part, without the distortion so common to some other hardening processes. The author showed microphotographs of the metal before and after treatment, and outlined the various engine parts susceptible to the hardening process, mentioning that large gas engine piston rods are being treated to reduce stuffing box wear.

In a paper, "Some Phase of Light Weight Diesel Design," P. B. Jackson, Aluminum Company of America, pointed out the advantages of using aluminum parts in high-speed engines. Because of their greater thermal conductivity, aluminum pistons can be made with correctly proportioned heads, at a cost not much if any greater than the cost of cast-iron pistons. The same reasoning indicates that rods, valve gear, and framing could be made of aluminum with advantage.

AT LEAST one American Diesel engine builder is using steel valve seats cast into the aluminum head, and has experienced no trouble from loosening in service. This construction becomes a necessity when valves are so close together that it is impossible to get sufficient material around the individual ring or valve seat. There is no objection to this practice from the foundry standpoint. All available information would indicate that there is little choice between the two constructions.

The problems of corrosion, the speaker stated, must be recognized, but with proper precautions does not preclude this material for use in salt water. Differentiating between corrosion and electrolysis, tests indicate that corrosion alone is not serious and with the use of inhibitors and protective coatings trouble should not be encountered. Electrolytic action, however, is a most serious problem, and it is essential that materials other than aluminum, which are in contact with the cooling water, should be insulated by non-metallic gaskets. Stud holes should be "blind" tapped, and copper base alloys should be avoided as far as possible in the system. Where bronze pumps and water piping are used, the connections to the aluminum parts of the engine should be made with rubber hose.

All water-jacketed aluminum parts, such as cylinder heads, cylinders and exhaust manifolds, should be treated with a corrosion inhibitor, as well as a protective coating of baked linseed oil.

"The Elimination of Torsional Vibrations," a paper by George J. Dashefsky, United States Navy, was a mathematical treatise on that subject.

At the Saturday afternoon session a paper by Dr. V. L. Maleev on natural-gas engines was read by George Reid in the author's absence. It dealt with the application of gas engines in the oil fields, and described recent improvements in gas mixing valves that increase engine efficiency.

C. G. A. Rosen, Caterpillar Tractor Company, San Leandro, Calif., in his paper, "The Diesel Engine Tractor and Excavator," outlined a study he had made on present engine types, and stated that the conclusion was reached that no existing Diesel meets all the requirements for a tractor engine. However, the pre-combustion engine is superior to the direct-injection Diesel in its ability to burn oil having a high carbon content. The best fuel-injection system seems to be a combination of the common-rail and pump-injection.

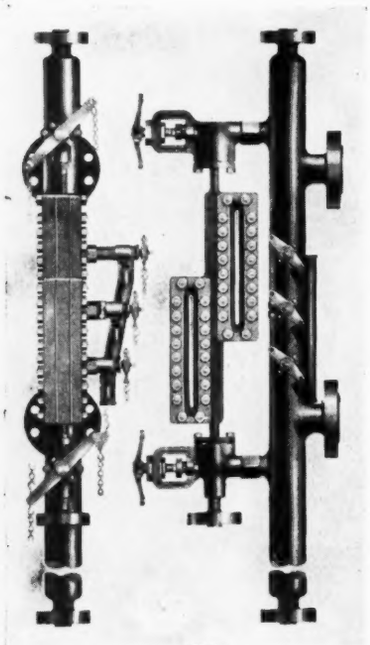
At this conference special attention was devoted to the entertaining of the engineers' wives. Various social events, such as teas, dances, card games, and automobile tours served to interest the feminine contingent.

WHAT'S NEW IN PLANT EQUIPMENT

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING, TRANSMITTING AND APPLYING THE POWER SERVICES

High-Pressure Gage Glass and Water Column

LOOSE-WINDOW construction features the new high-pressure gage glass and water column recently brought out by the Diamond Power Specialty Corporation, Detroit, Mich. The unit illustrated is for use on

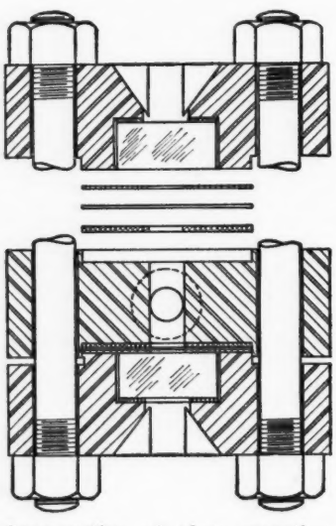


Water column and gage for pressures up to 1,500 pounds

pressures up to 1,500 lb., the highest boiler pressures now employed in this country. Certain refinements have been incorporated to obviate the troubles from glass breakage frequently encountered at high pressures.

Referring to the section, which shows the method of mounting the flat glass in the housing, the glass is virtually loose, acting only as a support for a thin mica strip which is clamped between the flanges at each side of the water and steam column forming the central member of the gage mounting. As there is actually no clamping tension exerted on the glass, it is not subjected to any greater pressure than the steam pressure itself. This construction relieves the glass of any stress due to the wide difference in expansion between the metal and the glass.

The water column to which the gage is attached is made with all-flanged connections and fitted with forged-steel valve bodies, renewable valve seats of stainless steel, self-aligning valve disks of Monel metal, and valve stems of the same metal, with threads external to the valve body. These stems operate through nuts mounted in the outer end of the valve bonnet. The gage cocks in the side of the column have renewable seats, disks, and stems.

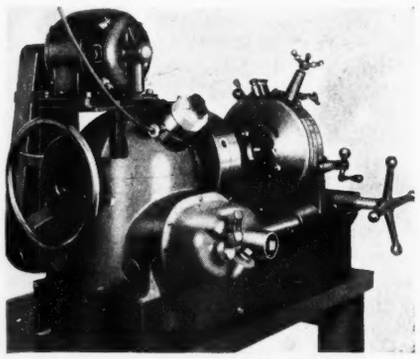


Cross-section of glass mounting

Improved Portable Bench-Type Threader

THE Williams portable pipe threaders put out by the Oster Manufacturing Company, and The Williams Tool Corporation, Cleveland, Ohio, are now being equipped with universal motors. This type of motor, according to the manufacturer, not only speeds up production, but also eliminates any tendency of the machine to stall, because the motor's speed is in direct proportion to the pull on the dies.

Features of the new bench-type



Bench type threader with universal motor

power threader illustrated are built-in cutting-off, reaming, and chamfering tools; built-in quick-opening die head that eliminates backing off; and two chucks—one a heavy gripping chuck and the other a self-centering universal chuck.

The machine illustrated, designed to thread, cut, ream, and chamfer all sizes of pipe from $\frac{1}{4}$ to 2 in., is available in both bench and pedestal types.

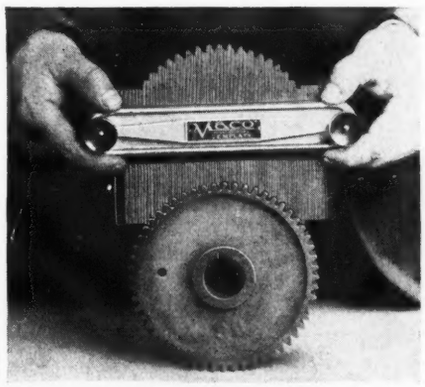
New High-Temperature Heat Insulation

THE Philip Carey Manufacturing Company, Lockland, Cincinnati, Ohio, has announced a new high-temperature heat insulating material to be known as "Carey Aluminite."

Developed in co-operation with the Aluminum Company of America, the new material is derived from bauxite, the ore from which aluminum metal is produced. It is designed for use in connection with firebrick boiler settings, heat-treating furnaces, regenerator chambers in iron, steel and other industries, and similar structures where internal temperatures ranges from 1,800 to 2,600 degrees.

Blocks for temperatures up to 2,000 deg. are now available. These are being made in one standard size, 9 in. wide, 36 in. long, and $2\frac{1}{2}$ in.

thick. One block is, therefore, the size of four standard bricks, the use of this size of block not only lowers the cost of erection, but reduces materially the number of joints in the insulating wall.



Template applied to a spur gear

Adjustable Template

AMONG the various duties of the maintenance engineer is checking and recording of wear on teeth of spur gears on important drives throughout his plant, measuring wear on sheave grooves of elevator equipment and also wear on wheels and rails of industrial conveyors. To these might be added other similar operations, which are, in general, greatly facilitated by the use of a template, especially if a ready check or comparison is desired of the wear taking place over certain periods of time.

An adjustable template that has been used in Great Britain for several years and particularly suited to work of this kind is now being introduced in this country by the Maco Template Company, 44 Whitehall St., New York City.

The tool consists of a large number of fine strips (0.007 in. thick) of hard-drawn brass set in an aluminum frame or housing. These laminations are made accurately to the same length and are held in position by clamps fitted with sections of corrugated rubber which definitely secure the laminae in any position.

In using the template, the clamps are lossened slightly and the end of the laminations are pressed against the gear or other member of which a template is desired. When the laminations have assumed the shape of the member against which they are pressed the clamp is tightened and the template is complete. The curve, of course, consists of steps 0.007 in. wide, but is smooth enough to allow of accurate work.

Gasoline Engines Equipped to Use Distillate Oil as Fuel

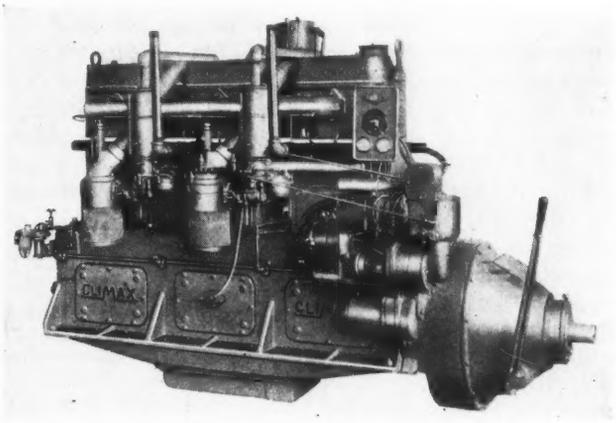
THE APPLICATION of equipment for the burning of distillate oil on its new "Blue Streak" engines is announced by the Climax Engineering Company, of Clinton, Iowa. These models are produced in sizes varying from 70 to 200 horsepower.

The important feature of oil burning as applied to these new engines, according to the manufacturer, is the high power and economy being obtained on cheaper fuel, giving about the same performance as gasoline on an average engine of the same displacement. All cylinders are of chrome-nickel iron. The bore and stroke are $5\frac{1}{2}$x$6\frac{1}{2}$ in., $5\frac{3}{4}$x$6\frac{1}{2}$ in. and 6x7 in. in the four-cylinder models, and 6x7 in. in the six- and eight-cylinder models.

Crankshafts are drop-forged, heat-treated, and are made of alloy steel in the larger sizes. The main bearings are babbitted and bronze-backed. Valves are in the head of the motor and are fully inclosed, the intake being made of nickel steel and the exhaust of silichrome.

Lubrication is supplied at a pressure of about 20 lb. to all bearings and overhead valve rockershaft bearings by a pump of the eccentric-vane type. A centrifugal pump with shrouded impeller furnishes the water circulation. In conjuction with the special carburetors used on these engines the intake manifold is jacketed with exhaust heat. Also, is a special device is added, a heat control for the primary air and water injection. The mechanism consists of a sylphon actuated by the change of pressure in the intake manifold.

To permit of higher power output and higher compression heads, water is injected into the intake manifold for throttle positions greater than three-quarter opening. This is controlled automatically. Full-load operation requires approximately $\frac{3}{10}$ lb. of water per brake-horsepower-hour to secure maximum output. No water is used for loads under three-quarters capacity.



A 135-hp. engine equipped to burn distillate oil

Industrial Tachometer

A TACHOMETER designed for use in industrial operations and adaptable to a wide range of applications is illustrated. Although the instrument shown is fitted with a dial graduated in yards per minute, instruments are available graduated in various other units, such as revolutions per minute, revolutions per hour, feet per minute and, in fact, any unit that can be indicated by an instrument of the type shown above.

Tachometer for flexible shaft drive

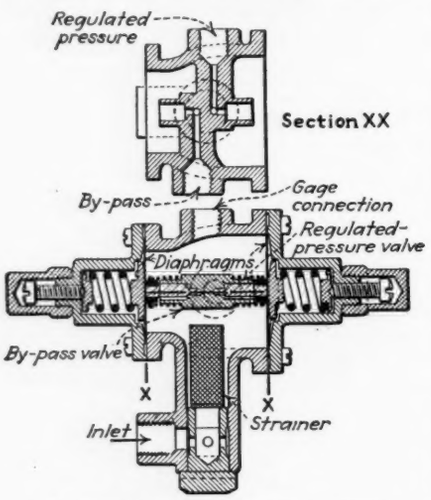
The tachometer shown is arranged to be driven by gears and flexible shafting, but units can be had arranged for belt drive. The tachometer is distributed by the Jones-Motrola Sales Co., 370 Gerard Ave., New York City.

Electrode for Thin Metal

"LIGHTWELD" is a new welding electrode announced by the Lincoln Electric Company, Cleveland, Ohio. It can be used on 16, 18, 20 or 22 gage metal in making a lap, butt or corner weld and is said to give a dense weld free from pin holes. It was designed to be used with a manual carbon arc and with from 30 to 60 amp. direct current and is suitable for horizontal, vertical or overhead work. The size of the rod is $\frac{1}{16}$ in. diameter and 30 in. long, and it is put up in 10 lb. containers.

Duplex-Pressure Regulating Valve

ALTHOUGH designed primarily for use between the pump and burner in oil-burning systems, the duplex-pressure regulating valve illustrated is suitable for other liquids where it is desired to control the pressure accurately from 100 to 150 lb. pressure at capacities up to 90 gal. per hour.



Sectional view of regulator valve

Liquid enters the valve at the bottom, passing upward through a strainer. Pressure is exerted upon two diaphrams clamped between the body flanges as shown. The larger diaphram, at the right, controls the pressure at which the liquid is discharged to the line. Should delivery of oil to the valve exceed the quantity for which the valve is set the diaphram at the left opens its valve and bypasses liquid to a reservoir or pump suction. Pressure at which each diaphragm will open is regulated by adjustment of the side springs. It will be apparent from the drawing that no liquid will be discharged from the valve until a pressure is developed sufficient to move the diaphram at the right against the resistance of the spring. Thus the valve functions only in a certain pressure range.

The valve is at present made only in the smaller sizes in aluminum, zinc, Monel metal, and brass. It is put out by the Monarch Manufacturing Works, Inc., 2730 East Westmoreland St., Philadelphia, Pa.

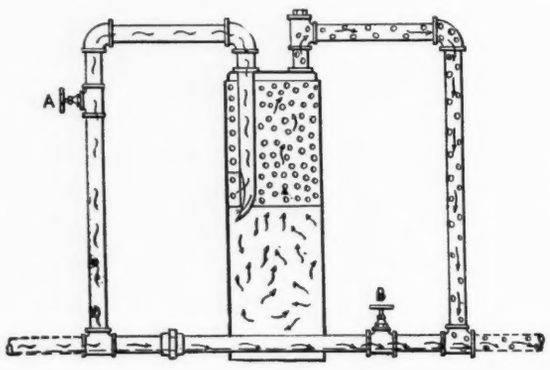
Gas to Prevent Freezing of Compressed Air Lines and Tools

THE principal trouble encountered with compressed air in low temperature is freezing of the air lines and tools as a result of moisture. Especially to obviate this trouble, as well as the frosting of tools during warm weather, a gas developed by C. H. Tanner is now being distributed by the Sullivan Machinery Company, Chicago, Ill.

Designated Tannergas, it is said to be harmless and non-explosive and to have a freezing point 70 deg. below zero. Its function in a compressed-air system is to saturate the moisture in the lines so that it cannot freeze at the lowest temperatures to which the lines may be subjected. It is claimed that it will not wash off or affect the lubrication of pneumatic tools.

Referring to the illustration, the system consists of a tank half filled with liquid and fitted with pipe connections and two valves, as shown. It is installed in existing compressed-air lines by simply removing a short section of the line, as indicated.

In operation, the upper valve *A* is open and the lower or bypass valve *B* is closed. This allows air to enter the tank, which agitates the liquid to a point where it gives off a gas. This gas passes out through the top opening of the tank with the air to the main air header, indicated by dotted lines. When not needed the system is readily cut out by opening valve *B* and closing valve *A*. The bypass valve *B* is of a special construction that allows a portion of the air to pass through it when it is closed. Any water that may collect will pass along the bottom line through the valve and be joined by the main body of air and gas from the tank. Tannergas is supplied in 30, 50 and 75 gal. drums.

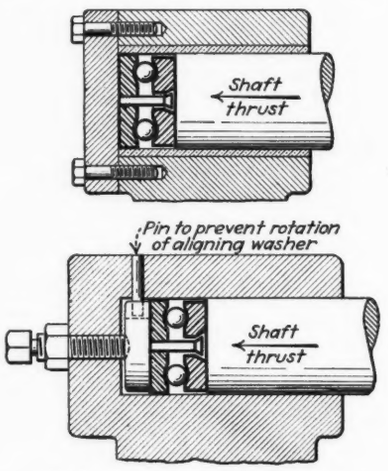


Tanner-Tank system connected in compressed air line

End-Thrust Ball Bearing

THE END-THRUST BEARING, T-114, illustrated, has been introduced by the Auburn Ball Bearing Company, 57-85 Clarissa St., Rochester, N. Y.

As will be apparent from the illustration, the bearing fits in a recess at the end of the shaft, the recess being of the same diameter as the shaft. Because of the small pitch diameter of the ball groove and the large size of balls used, the peripheral speed of the balls is relatively low. The two races and balls are held together as a unit by a pin which is flanged at one end and makes a force fit at the other, permitting of free rotation of the races yet holding them together.



Fixed and self-aligning bearing installation

Bearings are available in sizes from $1\frac{3}{16}$ to $3\frac{15}{16}$ in. in diameter.

NEWS of the FIELD

Spot News

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THE FIRST STEP *in the Claude-Boucherot process for extracting energy from the difference in temperature between the surface and depth of the sea near Cuba was accomplished recently when Georges Claude and Paul Boucherot, French scientists, succeeded in laying the pipe line that will bring cold water from the depths of the ocean to the surface. On the first attempt, some months ago, the pipe was broken by an extremely heavy sea.*

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ONE *of the greatest artificial reservoirs in the country will be created as a part of the proposed project of the White River Power Company on the White River, its North Fork and on Buffalo Creek. The dam on White River will be 225 ft. high, with a power-house installation of 270,000 hp. Installed capacity on the North Fork and Buffalo Creek will be 27,000 hp. and 7,500 hp., respectively.*

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AS OFFICIALS *of the Treasury Department contemplate the construction of a large central heating plant for the new public buildings to be erected in the triangle area south of the Capitol, an initial appropriation of $85,000 toward this end has just been provided in the second deficiency bill now before Congress.*

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A LICENSE *will be issued shortly to the West Virginia Power & Transmission Company for its proposed 600,000-hp. hydro-electric project on the Blackwater and Cheat Rivers, according to a report issued June 16 by the West Virginia Public Service Commission. The ultimate cost of this development will be approximately $100,000,000, with initial expenditures of more than $6,500,000.*

Iron and Steel Electrical Engineers Hold Annual Meeting and Exhibit

Interesting trip to steel mills and many technical papers are features of convention — Hussey elected president

FROM June 16 to 20 the Association of Iron & Steel Electrical Engineers held its annual convention iron and steel exposition in Buffalo, N. Y. The Hotel Statler was headquarters for the convention and the exposition was held in the Broadway Auditorium. This year as at previous conventions, the exposition was an outstanding feature of the program. Over 150 manufacturers of power equipment for steel mills exhibited.

An interesting part of the convention program was the trip to the Lackawanna plant of the Bethlehem Steel Company. To supply this plant with power there are two steam plants having a rating of 25,000 kva., and 24 banks of transformers rated at 58,550 kva. There are also 16 motor-generator sets, each consisting of a synchronous motor driving a 250-volt generator, having an aggregate capacity of 23,100 hp. For power transmission there is required 14.7 miles of 6,600-volt and 5.1 miles of 2,200-volt of overhead and underground lines. To drive the mills and operate the cranes a total of 3,481 motors and generators are required having an aggregate capacity of 262,572 horsepower.

Safety work has always had a prominent part in the activities of this association. At this year's safety session the paper "Should Colleges and Universities Create a Safety Engineering Course," by J. A. Voss, was a prominent feature. It is the author's opinion that since safety is already a part of the curriculum of some colleges and universities, other institutions should consider this subject. He said:

"It is highly fitting that we in America should develop a safety engineering course in our colleges and universities, and while a four-year course would not be desirable and would not be in great demand either on the part of students or industries, nevertheless, it would require at least two years to teach the student all detail and ideals of sharing opportunity and responsibility for the conservation of life and limb. The detail of a course as outlined can best be developed by a committee selected from the faculty of a number of leading colleges and universities. If this committee should desire advice or guidance on this important subject I am certain that organizations specializing in safety stand ever ready to assist them."

A comprehensive report was presented by the special committee on bearings, containing information on anti-friction bearings for mill-type motors, general purpose motors, and electric overhead traveling cranes. An important part of this report is 38 tables of motor and anti-friction bearing data. A proposed specification for cranes was also presented.

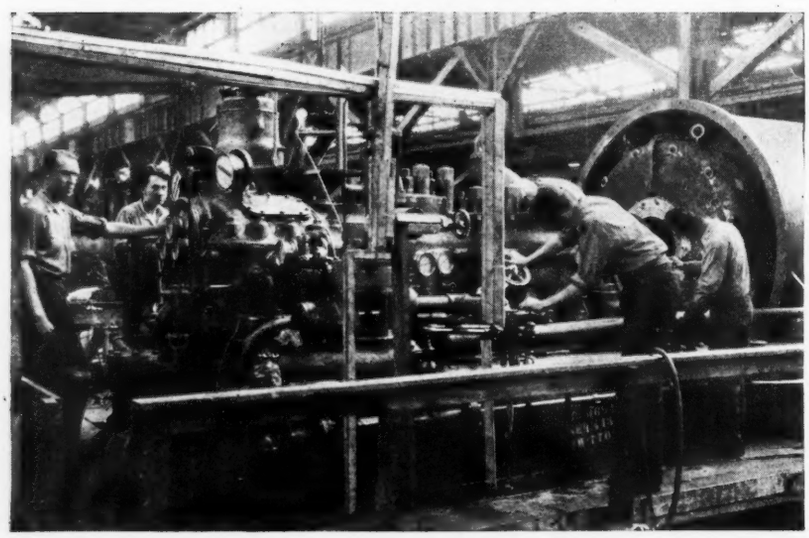
Roland M. Hussey of the James and Laughlin Steel Corporation, Aliquippa, Pa., was named president of the association at the annual election of officers. The other new executives are Fred O. Schnure, Bethlehem Steel Company, Sparrows Point, Md., first vice-president; Jesse J. Booth, National Tube Company, Gary, Ind., second vice-president; William E. Miller, Bethlehem Steel Company, Johnstown, Pa., secretary, and James Farrington, Wheeling Steel Corporation, Steubenville, O., treasurer.

Enormous Blowers Ordered for Blast Furnace

An order for two extraordinarily large steam-turbine blowers for use with blast furnaces has just been given by the Tata Iron & Steel Company of Jamshedpur, India, to Escher Wyss & Company of Zurich, Switzerland, according to an announcement by the National Power Machinery Corporation, New York agents of the Escher Wyss company. Each of these blowers will be capable of delivering 130,000 cu.ft. of free air per minute against a pressure of 27 lb. per square inch gage. The air from the blowers will pass through air heaters before entering the blast furnace. The steam turbine driving these blowers will have a capacity of 13,700 hp. each.

The blast furnaces require the turbine-blowers to operate under wide variations of load and revolutions per minute, and the blowers must remain under automatic control.

LAKESIDE'S NEW HIGH-PRESSURE UNIT



Testing the fourth 1,200-lb. steam turbine for the Milwaukee Electric Railway & Light Company in the Schenectady works of the General Electric Company. This unit operates at 3,600 r.p.m. and develops 7,700 kw. Besides two high-pressure units, the Milwaukee company is installing a 60,000-kw. turbine-generator in its Lakeside station

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A.O.S.E. and A.S.M.A. Hold Convention and Exhibit

The 44th annual convention of the American Order of Steam Engineers was held in the City of Philadelphia, Pa., on June 9-12, at the Grand Fraternity Building. The convention and exhibit of the American Supply Mens Association was jointly opened by an address of welcome by George Elliott, secretary of the Bureau of Commerce. Thomas Small, supreme chief of the American Order of Steam Engineers, and Harry Sonders, chairman of the American Supplymen's Association.

The convention was one of the most profitable and instructive of the American Order. Many interesting papers were read, and action taken for the advancement of practical engineering. The condition of each council has progressed numerically and financially during the past year.

A very fitting tribute was paid to Benjamin Franklin by a contribution to the Franklin Memorial Fund Building to be erected in Philadelphia, Pa., at a cost of $7,500,000.

The exhibit of the Supplymen's association was one of great credit to the officers of that association and a benefit to each of the exhibitors.

Officers elected and installed for the ensuing term include: supreme chief—Thomas Small, Atlantic City. N. J.; supreme first assistant—Richard Sinnott, Camden, N. J.; supreme recording engineer—George Farney, Coplay, Pa.; supreme corresponding engineer—Charles F. Burger, Philadelphia Pa.; supreme treasurer engineer—Lewis G. Schlehner, Elkin Park, Pa.

The officers of the Supplymen's association for the ensuing year are: chairman—Harry Sonder, Philadelphia, Pa.; secretary—L. G. Crater, Philadelphia, Pa.; director of exhibits—J. Everitt Downs, Philadelphia, Pa.; treasurer—Jesse G. Haydock, Philadelphia, Pa.

To Commemorate Invention of Modern Scale, July 4

To commemorate the invention of the modern platform scale by Thaddeus Fairbanks in 1830 business and industrial leaders of the nation and of many foreign countries will gather in the historical city of St. Johnsbury, Vt., on July 4 to pay tribute to the memory of Thaddeus Fairbanks "father of modern weighing," who gave to the world its first accurate standard of weights a hundred years ago.

Announcement of a three-day celebration of the centennial of the invention of the modern weighing machine beginning July 4 was made recently in Chicago by W. S. Hovey, president of Fairbanks, Morse & Company, which is the outgrowth of the small-scale manufacturing business started a hundred years ago at St. Johnsbury by Thaddeus Fairbanks and his brothers Erastus and Joseph P. Fairbanks on an investment of $4,000.

Former President and Mrs. Calvin Coolidge will be guests of honor at the celebration, which has the sponsorship of the Vermont Hostorical Society, the New England Advisory Council, and the Chamber of Commerce. Mr. Coolidge has a keen personal interest in the affair for the reason that he was at one time a student at the St. Johnsbury Academy, which was sponsored and supported by Thaddeus Fairbanks.

The principal feature of the program will be an historical pageant depicting the progress during the last century in the evolution of the modern weighing machine and its profound influence upon human welfare and world commerce. There will also be a notable exhibition of original patent models of scales invented by Fairbanks, which have been borrowed for the occasion from the patent office.

First Installation in U. S. of 3-Wire 66-Kv. Cable

Four overhead 66-kv. circuits between the transformers at its Columbia Park generating station and its terminal transmission lines are to be replaced with three-conductor cable of like capacity by the Union Gas & Electric Company, of Cincinnati. It will be the first such installation in this country, and is to be used in filled ground which is subject to submersion by flood stages of the river at certain times and to very dry conditions at other periods. The oil-filled armored cable, covered, in turn, with paper insulation, a lead sheath, a layer of asphalted jute, two band steel tapes, and an outside layer of asphalted jute, is not affected by either excessive wetness or dryness.

The cable, being built by the General Electric Company, will be shipped and installed in five lengths, each approximately 1,300 ft. long. Four of the cables are to carry load (37,500 kva. each) at one time; the other cable will be a spare. Thirty-two oil-filled terminals and twelve feeding-type oil reservoirs will be used with the installation.

Course at M.I.T. Combines Business and Engineering

Business training with an engineering background as a preparation for management in commerce and industry will be given in a separate department of undergraduate and graduate instruction at the Massachusetts Institute of Technology next autumn, it was announced recently. Under this plan the present course in engineering administration, which was started in 1914, is to be established as the Department of Business and Engineering Administration.

This unique step in engineering education is taken in recognition of the growing demand for technically trained men in the field of business management. The Institute's present course, with 298 students this year, is now one of the largest in Technology.

Senate May Take Action on Engineering Museum Bill

Recent developments in the Senate Committee on Education and Labor indicate that action will be taken before adjournment on the Copeland bill for the establishment of a national museum of engineering and industry. A subcommittee has been considering the bill, and it is now reported that favorable recommendations will be made to the Senate by the full committee. Senator Copeland's bill contemplates the establishment of a suitable museum for engineering and industrial exhibits. The direct step authorized by the measure, however, is for the purpose of creating a commission to study the matter.

In carrying out the Federal Government's improvement program in the triangle area south of the Capitol, it will be necessary to demolish the structure housing the present industrial and engineering exhibits owned by the Smithsonian Institution. Museum authorities have realized for some time, however, that even though the present structure were left standing the housing facilities would still be inadequate for the engineering and industrial exhibits. The commission authorized by the bill to study the matter will be required to make its report to Congress on or before June 30, 1931.

Contract Insures Tacoma's Power Supply

To insure an ample supply of electric power during the coming summer and fall, the municipal light department of Tacoma, Wash., has entered into a contract with the Puget Sound Power & Light Company, Seattle, to buy current from that company, when and if necessary. The step has been taken to guard against last fall's power crisis in Tacoma, when the Navy Department loaned the aircraft carrier Lexington to the city to generate electricity. The contract with the power company is for a term of one year. Before its expiration, Tacoma's Lake Cushman hydroelectric project is expected to be completed, and the arrangement will no longer be needed, according to city light officials. The Lake Cushman job is to be finished next November, it is said.

Under the contract the City of Tacoma is to give the private company the first call when additional power is needed. The contract does not nullify the tie-up of the Tacoma and Seattle municipal light plants which was effected during last fall's shortage. The tie-up must be suspended, however, when Tacoma is receiving power from the private company, because of a difference in voltage.

W. H. McGrath, vice-president of the Puget Sound Power & Light Company, has stated that the rates will be five mills, under the contract, for hydroelectric power when available; eight mills for steam generated current when the Shuffleton plant at Renton is operating; and one cent a kilowatt-hour for steam-produced power when it is necessary to start the Shuffleton plant especially to aid the city. Tacoma authorities estimate it may be necessary to buy a total of 50,000,000 kw.-hr. under the contract.

Trade Commission Examines Foshay Failure

Probing into the affairs of the W. B. Foshay Company of Minneapolis during the past week, the Federal Trade Commission has not been dealing with a prosperous and well managed group, as in past hearings, but with one now in receivership. Several significant facts as to the causes of failure were brought out by the commission examiners.

It was shown that dividends, large salaries, and bonuses were paid out of capital. The firm made a practice of selling properties, with a write-up of, say, 20 per cent, to its own subsidiaries, such as the Public Utilities Consolidated Corporation. In some cases it would take stock from the subsidiary as payment before the property involved in the transaction was acquired. The stock would be sold to finance the purchase but the market would not take all of it at the end. Dividends were paid to the verge of bankruptcy. A favorable balance was shown on the books on the basis of the incomplete stock transactions though an actual deficit existed.

News of Canada

Shawinigan makes rapid progress on St. Maurice projects—Beauharnois operations speeded up—Work started at Abitibi canyon

SHAWINIGAN Water & Power Company is making good progress in connection with its water-power developments in the Upper St. Maurice district of the Province of Quebec. Altogether, the company plans to develop 1,250,000 additional horsepower. Construction work this year is being carried out in two sections. The first has to do with the Rapide Blanc development which is planned for an installation of 160,000 hp., and the other with the new storage dam at Toro Rapids on the Mattawin River. The principal work at Rapide Blanc at the moment consists in the construction of a 10-mile concrete highway from the nearest point on the Canadian National Railway to the site. Over 800 men are engaged in building the highway, which is expected to be completed this fall. This will give the company sufficient time to truck in supplies and materials to the camp so that winter work can be carried on without cessation.

Four hundred men are engaged in work at Toro Rapids. At present the men are engaged in constructing a temporary dam above the site where the permanent structure will be established. In this way, it will be possible to back the river up. This will permit the engineers to float down the river heavy

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LOWER TALLASSEE NEARS COMPLETION

With an installation of 72,000-hp. capacity, the Lower Tallassee plant of the Alabama Power Company located on the Tallapoosa River is rapidly approaching completion. The dam is 1,846 ft. long, and the units operate under a normal head of 91 ft. This is the company's third plant on the river, others being Martin Dam, 135,000 hp., and Upper Tallassee, 50,000 horsepower

equipment required for building operations. The dam, when finished, will be 90 ft. from sill to crest and 2,400 ft. in length on the crest. Nearly one-fifth of the length will be a concrete structure, containing regulation gates, and the balance an earth fill. The dam will impound 33,000,000,000 cu.ft. of water and be of great benefit as it will improve the regulation of the water at the company's plants on the St. Maurice River.

OPERATIONS on the Beauharnois power project on the St. Lawrence River are being speeded up. At present the Beauharnois Power Corporation has assembled and placed in operation, on a 24-hour a day basis, its full quota of excavating equipment. Much of the work during recent months has included the assembly and erection of the large scale equipment which it is expected will carry out the project on a satisfactory cost basis. Substantial progress has also been made on the construction work itself. The dragline shovels, which went into action last autumn, have completed many miles of dyking along the route of the power canal. The construction railway now operates on 13 miles of track; within a few weeks it will parallel the route of the canal, a distance of 15 miles. In the blasting operations at the power house site, 200,000 cu.yd. of rock have been moved.

ENGINEERING PARTIES are already at work on the proposed hydro-electric development of the Hudson's Bay Power Company, in Northern Ontario. A dam and power house are to be built at Abitibi Canyon, 65 miles north of Cochrane. The plant is being designed to develop 275,000 hp., of which 100,000 hp. has been sold to the Hydro Electric Power Commission.

W. H. Bristol Dies

William Henry Bristol, inventor and president of the Bristol Company, Waterbury, Conn., died June 18 at the New Haven Hospital, after an illness of several months. He was internationally known for his scientific work in connection with the development of recording instruments for measuring pressure, temperature, electricity, speed, and time.

Professor Bristol was born on July 5, 1859, in Waterbury and was graduated from Stevens Institute of Technology at Hoboken, N. J., in 1880, having taken an M. E. degree in four years. Subsequently, he was an instructor and, later, professor of mathematics at Stevens. He founded the Bristol Company in 1899 to manufacture and market his inventions and dominated the business throughout its existence without ever letting up on his scientific activities.

He was a member of many scientific societies, including the American Society of Mechanical Engineers, the Electro-Chemical Society and the Society of Motion Picture Engineers.

Elmer A. Sperry Dies; Was Famous Inventor

Elmer Ambrose Sperry, internationally famous inventor and engineer, died June 16 at St. John's Hospital, Brooklyn, N. Y., from complications which set in after he had recovered from an operation for gallstones six weeks ago. With more than 50 years of his life devoted to invention, he was said to have taken out nearly 400 patents.

Born in Cortland, N. Y., October 12, 1860, Mr. Sperry was educated at the

Elmer A. Sperry

State Normal School in Cortland and Cornell University. In 1879, when not yet twenty, he had become the inventor of a successful device for the perfection of the first electric arc light in America, and soon after he constructed what is believed to be the first town lighting system. With this beginning, many inventions followed in rapid succession, including the world-famous gyroscope, a compound Diesel engine using the lowest grade fuel oil with high efficiency, and the metal-flow detector, his last.

Previous to 1910 there were already six industrial corporations founded to manufacture Sperry's inventions, doing then an aggregate annual business of over $5,000,000.

In January, 1929, he sold the Sperry Gyroscope Company, of which he was president, to the North American Aviation Company, and soon after started building up the Sperry Development Company, Inc., and also the Sperry Rail Service Corporation. Just this year he had organized Sperry Products, Inc., as successor to the two last-named companies.

The recipient of many honors, Mr. Sperry was one of the founders and charter members of the American Electro-Chemical Society and the American Institute of Electrical Engineers. He was past-president of the American Society of Mechanical Engineers and a member of many other technical and scientific organizations and the recipient of numerous awards and medals. Last year he took an active part in the organization and carrying out of the World Engineering Congress in Japan.

Personals

R. C. DICKINSON and B. P. BAKER, electrical engineers with the Westinghouse Electric & Manufacturing Company, are the recipients of the national first prize awarded by the American Institute of Electrical Engineers for exceptional work in the field of engineering practice. They received the award for their paper, "Structural Development of the De-ion Circuit Breaker."

FRANK L. EIDMANN has resigned as associate professor in the School of Engineering of Princeton University to become professor of mechanical engineering at Columbia University.

W. WINGER of Ottumwa, Ia., was elected president of the Iowa Association of the National Association of Power Engineers at the 27th annual convention held recently in Sioux City. Mr. Winger succeeds W. W. GASSER of Sioux City. Other officers were elected as follows: J. A. MURPHY, Des Moines, vice-president; C. A. BLAND, Des Moines, re-elected secretary; and CHARLES AMOS, Sioux City, treasurer.

H. H. MATTHES, district engineer at Norfolk, Va., for the United States War Department, was at Danville, Va., recently on an inspection trip in connection with the survey of the Dan and Roanoke Rivers. This is a part of the government's national survey of streams to determine power possibilities and to gather data relative to the proposed flood control program.

HAROLD S. FALK, vice-president and works manager of the Falk Corporation, was recently awarded an honorary degree of Master of Science by Marquette University in recognition of the work done by him in the promotion of the apprentice training movement in American industries.

E. F. PEARSON, formerly electrical engineer of the Northwestern Electric Company, Portland, Ore., has been appointed chief engineer of that company.

EDWIN JAY PRINDLE, chairman of the Patents Committee of the American Engineering Council and leader in the movements that resulted in the reform of the United States Patent Office, recently received the honorary degree of Doctor of Laws from National University at Washington, D. C.

CUMMINGS C. CHESNEY, vice-president of the General Electric Company and chairman of its manufacturing committee, will retire at his own request July 1, and will be succeeded by Vice-President WILLIAM R. BURROWS. Mr. Chesney was associated with the late WILLIAM STANLEY, who developed the transformer. He has seen more than 42 years continuous service in the electrical industry.

Business Notes

LINK-BELT COMPANY, Chicago, Ill., announces the appointment of the following direct representatives for the sale of shovels, cranes and draglines: W-D-M Equipment Company, Box 329, Columbia, S. C.; Myer & Cunningham, 30 Church St., New York City; Barzee Equipment Company, 1223 Burnet Ave., Syracuse, N. Y.; S. G. Hawkins Company, 723 Washington Ave., Houston, Texas; Lewis-Patten Company, San Antonio, Texas; West Virginia-Kentucky Hardware & Supply Company, Huntington, W. Va.

BLAW-KNOX COMPANY, Pittsburgh, Pa., announces the addition to its sales staff of John E. Chiquoine, formerly with the E. I. Du Pont de Nemours & Company and the American Chemical Machinery Company. It is also announced that William E. Balliet succeeds P. V. Kelly as manager of the company's Birmingham, Ala., office. Joseph Riley has been made assistant manager of this office.

BYRON JACKSON COMPANY, Berkeley, Calif., has discontinued its San Francisco office. All business is being transacted through the company's main office at the foot of Carlton Street in Berkeley, where Eck L. Baughn is in charge of city sales.

HOOVER STEEL BALL COMPANY, Ann Arbor, Mich., announces the appointment of H. E. Johnson to its sales organization. Mr. Johnson was formerly sales manager of the Strom Steel Ball Company.

EDWARD VALVE & MANUFACTURING COMPANY, East Chicago, Ind., has appointed Riffe & Thomas, Inc., successor to the W. A. Ross Company as its representative in Charleston, W. Va.

THE BRISTOL COMPANY, Waterbury, Conn., has been granted a manufacturing and selling license by the Dardelet Threadlock Corporation under its patents for self-locking screw threads.

THOMAS GRATE BAR COMPANY, Birmingham, Ala., announces the appointment of the Economy Equipment Company, 301 Buder Building, St. Louis, Mo., as its representative for the middle and eastern portions of Missouri and southern Illinois, with J. T. Vollbrecht in charge. The company has also appointed Charles Rinck & Brother, 1638 Cedar Ave., Cincinnati, Ohio, sales agent for Cincinnati and the surrounding territory.

PULVERIZED FUEL EQUIPMENT COMPANY, a division of BORG-WARNER CORPORATION, Chicago, Ill., has appointed the following direct sales representatives: E. L. Sullivan, Oliver Building, Pittsburgh, Pa., and H. P. Rogers & Company, Leader Building, Cleveland, Ohio.

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COMING CONVENTIONS

American Society of Mechanical Engineers. Annual meeting in New York City, Dec. 1-5. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Society of Heating & Ventilating Engineers. Annual summer meeting at the Curtis Hotel, Minneapolis, Minn., June 24-27. Secretary, A. V. Hutchinson, 51 Madison Ave., New York City.

National Association of Power Engineers. Annual convention and exhibition of power machinery at the Cleveland Auditorium, Cleveland, Ohio, Sept. 8-13. Secretary, Fred W. Raven, 417 South Dearborn St., Chicago, Ill.

National Association of Practical Refrigerating Engineers. Annual convention and exhibition at the Hotel Peabody, Memphis, Tenn., Nov. 11-14. Secretary, Edward H. Fox, 5707 West Lake St., Chicago, Ill.

National Exposition of Power and Mechanical Engineering. Grand Central Palace, New York City, Dec. 1-6. Manager, Charles F. Roth, Grand Central Palace, New York City.

Smoke Prevention Association. Annual convention at the Hotel Robert Treat, Newark, N. J., June 24-27.

Universal Craftsmen Council of Engineers. Annual convention at the Hotel Kimball, Springfield, Mass., Aug. 5-8. Secretary, T. H. Jones, 33 Linden Ave., Cherrydale, Va.

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Trade Catalogs

CONTROLLERS—Catalog No. 2200 on American precision temperature and pressure controllers, recently printed by the Consolidated Ashcroft Hancock Company, Bridgeport, Conn., deals with the application of these instruments to installations where the control of critical temperatures is important.

NICKEL STEEL—The International Nickel Company, 67 Wall St., New York, N. Y., has just issued the following two folders: No. 15 on nickel-chromium steels for high-temperature service valves and bolts, and No. 16 on the approximate relations between Brinell, Rockwell and Shore Hardnesses and the tensile strength of structural alloy steels.

EQUIPMENT—Produced in conjunction with the celebration of the centennial anniversary of the invention of the platform scale by Thaddeus Fairbanks, the new bulletin of the Fairbanks Morse Company, 900 South Wabash Ave., Chicago, Ill., is a piece of institutional literature.

GAGES—Two folders have recently been printed by the Ellison Draft Gage Company, 214 West Kinzie St., Chicago, Ill. Bulletin 14 covers the Ellison air filter gage, pointer type, and Bulletin 10-B describes the Ellison pointer draft gages, with the straight-line movement.

SWITCHING EQUIPMENT—A number of folders have recently been sent out by the General Electric Company, Schenectady, N. Y., dealing with this type of equipment: GEA-1200 on Type MC-2 air circuit breakers, GEA-959A on Type FKR-55 oil circuit breakers, GEA-1199 on automatic switching equipment, GEA-925A on station oil circuit breakers, GEA-1197 on Type BK2-brush-contact switches, GEA-286C on outdoor switching equipment, GEA-1186 on hook-operated disconnecting switches and GEA-1168 on testing equipment.

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Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	At Mine, for Shipment to	Price per Ton
Navy Standard...	New York.....	$2.25 @$2.50
Kanawha.....	Cincinnati.....	1.15 @ 1.35
Smokeless.....	Cincinnati.....	1.85 @ 2.00
Smokeless.....	Chicago.....	1.75 @ 2.00
West Kentucky...	Chicago.....	.85 @ 1.30
Steam.....	Pittsburgh.....	1.40 @ 1.65
Gas Slack.....	Pittsburgh.....	1.10 @ 1.25
Big Seam.....	Birmingham....	1.60 @ 1.75
Anthracite		
(Gross Tons)	At Mine, for Shipment to	Price per Ton
Buckwheat.....	New York.....	$2.90 @$3.00
Barley.....	New York.....	1.15 @ 1.50

FUEL OIL

New York—June 19, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.75@5.25c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6@6.25c. per gal.

St. Louis—June 12, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.420 per bbl., or 42 gal.; 26@28 deg., $1.545 per bbl.; 28@30 deg., $1.620 per bbl.; 30@32 deg. $1.695 per bbl.; 32@36 deg., gas oil, 4.135c. per gal.; 37@40 deg., distillate, 4.98c. per gal.

Pittsburgh—June 11, f.o.b. local refinery, 30@34 deg., fuel oil, 3.625c.@3.75c. per gal.; 36@40 deg., 3.5c.@4.25c.

Philadelphia — June 3, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 18 deg. plus, $1.475@$1.525 per bbl.; 23@27 deg., $2.00@$2.05 per bbl.

Cincinnati — June 10, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5.25c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.75c. per gal.

Chicago—June 14, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 75@80c. per bbl.; 26@30 deg., 85@90c. per bbl.; 30@32 deg., $0.95@$1.00 per bbl.

Boston—June 16, tank-car lots, f.o.b., 12@14 deg., Baumé, 3.32c. per gal.; 28@32 deg., 5c. per gal.

Dallas—June 14, f.o.b. local refinery 26@30 deg., $1.25 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Pasadena—City is having plans prepared for addition to light plant. Estimated cost $150,000. Bennett & Haskell, First Trust Bldg., are engineers.

Calif., Sacramento—Pacific Coast Ice Hockey League, c/o Starks & Flanders, Forum Bldg., Archts., is having preliminary plans prepared for a 300 x 300 ft. skating rink on Alhambra Blvd. Estimated cost $750,000.

Conn., Hamden—Connecticut Co., 185 Church St., New Haven, will soon award contract for the construction of a 1 story, 25 x 40 ft. power sub-station, here. Estimated cost $40,000. R. W. Foote, 185 Church St., New Haven, is engineer.

Ind., Indianapolis — Indianapolis Power & Light Co., N. Perry, Pres., 327 South La Salle St., Chicago, Ill., will build a super power station, including two 35,000 kw. turbo generators, eight 1,200 hp. power boilers at South Harding St. and White River. Estimated cost approximately $12,267,075.

Ia., Ottumwa — City awarded contract for three complete units including water wheels and generators for hydro-electric plant to Allis-Chalmers Co., West Allis, $125,184.

Md., Baltimore — Buena Vista Apartment Corp., awarded contract for the construction of a 10 story apartment building at Charles and 33rd Sts., to White Construction Co., Garrett Bldg. Estimated cost $650,000. Vacuum steam heating system, elevators, etc., will be installed.

Md., Baltimore—City awarded contract for the construction of a 46 x 129 ft. pumping station in Druid Hill Park to Consolidated Engineering Co., 20 East Franklin St. $129,700.

Mass., Gloucester—Bd. of Water Commissioners, 10 Proctor St., will receive bids until June 28, for the construction of a waterworks system including dam, reservoir, pumping station, etc. Estimated cost $250,000. Fay, Spofford & Thorndike, 44 School St., Boston, are engineers.

Mass., Lawrence — Meadow Brook Laundry Co., 17 North Methuen St., is receiving bids for the construction of a power house on North Methuen St. Estimated cost $40,000, including equipment. H. Petzold, Bay State Bldg., is engineer.

Mass., New Bedford — Bd. of Aldermen, Municipal Bldg., plans the construction of a generating plant. Estimated cost to exceed $40,000. Private plans.

Mass., Worcester—Worcester Electric Light Co., 2 Foster St., awarded contract for the construction of an electric power sub-station at 66 Taraday St. to New England Power Construc-Co., 89 Broad St., Boston. Estimated cost to exceed $40,000.

Minn., Duluth — Minnesota Power & Light Co., W. H. Burke, Pres., 30 West Superior St., plans to expend $285,000 for the construction of a power distribution system, including transformers, etc., between Sixth Ave. W. and Fifth Ave. E., and between Commerce St. and Fourth Alley.

Minn., Moorhead — State Commission of Administration & Finance, Capitol, St. Paul, is having plans prepared for the construction of a 3 story administration building and power plant at State Teachers College to replace fire loss. Estimated cost $200,000. C. H. Johnston, 360 Robert St., St. Paul, is architect.

Minn., St. Paul—Arcade Investment Co., H. Lowry, Pres., 1 South 11th St., Minneapolis, awarded contract for the construction of a 16 story office building at 4th, Wabasha and St. Peter Sts. to F. J. Romer Construction Co., 190 Ramsey St., St. Paul. Estimated cost $1,200,000. Steam heating system, etc. will be installed.

Mo., Bagnell—Union Electric Light & Power Co., 315 West 12th Blvd., St. Louis, awarded contract for electrical equipment, including six 23,888 kva. umbrella type vertical waterwheel generators, two 3,000 kva. vertical waterwheel generators and seven 150 kw. motor generator exciter sets, etc., to be installed in hydro-electric plant on Osage River at Bagnell now under construction, to Westinghouse Electric & Mfg. Co., 411 North 7th St., St. Louis. Estimated cost $1,000,000.

Mo., Kansas City—W. R. Nelson Trust, c/o Wight & Wight, 400 First National Bank Bldg., Archts., plans the construction of a bank building, including power house at 44th St. and Rockhill Rd. Estimated cost $1,000,000.

Mo., St. Louis — Terminal Railroad Association, 1800 Market St., will soon receive bids for a 13, 16 or 18 story merchandise mart, office and warehouse and exposition building at 12th, 13th, Spruce and Poplar Sts. Estimated cost $5,000,000. St. Louis Mart, Inc., c/o H. C. Martin, 315 North 10th St., et al., lessee.

N. J., Camden—Public Electric & Gas Co., 80 Park Pl., Newark, is having sketches made for the construction of a switching station, here. Estimated cost $150,000. Private plans.

N. J., Jersey City — Mogiello Bros., 625 Communipaw Ave., is having plans prepared for the construction of a 100 x 100 ft. ice plant. Estimated cost $40,000. C. H. Ziegler, 26 Journal Sq., is architect.

N. J., Teaneck—North Jersey Service Corp., Cedar Lane and River Rd., will soon award contract for the construction of an apartment, office and stores building, etc., including steam heating and ventilation systems, boilers, etc. Estimated cost $750,000. P. J. Jossier, 240 Broad St., Palisade Park, is architect.

N. Y., Brooklyn — Long Island Hospital, awarded contract for the construction of a 45 x 100 ft. boiler and power plant at Pacific and Henry Sts. to Turner Construction Co., Graybar Bldg., New York. Estimated cost $40,000.

N. Y., Central Islip — Dept. of Mental Hygiene, State Office Bldg., Albany, will receive bids until July 16 for the construction of sewage-pumping stations at Central Islip, State Hospital, Suffolk County.

N. Y., Dannemora — Dept. of Correction, Capitol, Albany, received lowest bid for new power house service tunnel and service connections at Clinton Prison here from National Concrete Fire Proofing Co., 925 Citizens Bldg., Cleveland, O.

N. Y., Willard — Dept. of Mental Hygiene, State Office Bldg., Albany, will receive bids until July 16 for renewal in part and enlargement of cold storage and ice making plant at Willard State Hospital here.

O., Columbus—Bd. of County Commissioners, F. L. Donnally, Clk., will receive bids until July 16 for additions and alterations to power plant at Franklin County Home.

Utah, Heber—City plans an election July 8, to vote $75,000 bonds for the construction of a municipal hydro-electric light plant. Engineer not selected.

Ont., Riverside—Town, is having plans prepared for sewer extensions, including sewage disposal plant and pumping station. Estimated cost $40,000. G. G. Reid, Town Hall, is engineer.

Ont., Sudbury — Hydro-Electric Power Commission of Ontario, 190 University Ave., Toronto, plans the construction of a high voltage substation to step down from 220,000 v. in connection with power to be transmitted from Abitibi Canyon. Estimated cost $250,000. F. A. Gaby, 190 University Ave., Toronto, is engineer.

Equipment Wanted

Air Brake Switch, etc.—Wellington, N. Z.—Public Works Supplies & Tenders Committee, will receive bids until Sept. 30 for a 3 ph., 50 kv., 200 amp. mechanically operated air brake switch, steel structure, set busbars, insulators and connections and set spares.

Boilers—Superior, Wis.—State Teachers College, A. D. S. Gillett, Pres., 801 North 16th St., will receive bids in July for replacement of boilers of heating plant. Estimated cost $35,000.

Boilers, Stokers, Conveying Equipment, Engines, etc.—St. Louis, Mo.—Bd. of Education, 911 Locust St., will receive bids until July 1, for boilers, stokers, conveying equipment, uniflow engine, four valve engine, Diesel engine, generators and exciters, switchboard, motor generator sets, etc., for proposed 70 x 150 ft. power house on School So. Estimated cost $248,000.

Generator Room Equipment—Churchill, Man.—Dept. of Railways & Canals, J. W. Pugsley, Secy., will receive bids until July 10 for generator room equipment for power plant.

Motors — Stratford, Ont. — H. & S. Screw Products Co., 5676 12th St., Detroit, Mich., plans to purchase new 60 cycle electric motors for recently acquired plant here.

Power Equipment—Seguin, Tex.—Texas Hydro-Electric Co., is receiving bids for machinery and equipment for three dams on the Guadalupe River between Gonzales and Seguin. Each dam will have a 3,000 hp. unit. Contract for construction of dams awarded to Sumner Sollitt Construction Co., National Bank of Commerce Bldg., San Antonio. $900,000. Total estimated cost $2,000,000.

Pumps — Harlingen, Tex. — Cameron Co. Water Improvement Dist. No. 15, c/o S. Finley Ewing-Rio Grande Nat. Life Co. Bldg., will receive bids until July 10 for the installation of pumps, etc., in connection with irrigation work.

Pumps and Motors—Woodward, Okla.—City is in the market for three deep well pumps and motors for waterworks.

Industrial Projects

Conn., Hartford—Superior Spring & Mfg. Co., 373 Washington St., awarded contract for a 2 story, 60 x 130 ft. factory on Washington St. to S. Martin, 107 Love Lane. Estimated cost $65,000.

Ind., Fort Wayne—General Electric Co., 1635 Broadway, awarded contract for the construction of a factory on Writter St. to Indiana Engineering & Construction Co., 201-3 Central Bldg. Estimated cost $41,000. Addition to electric sub-station at Lawrence St., Bloomfield, N. J., to R. Allen Inc., 319 Mt. Pleasant Ave., Newark. $40,000.

Ind., Greensburg—Cyclone Fence Co., awarded contract for the construction of a power house to Krebay Construction Co., 802 New City Institute Bldg., Indianapolis. Estimated cost $40,000.

Kan., Wichita—United Aircraft & Transport Co., awarded contract for the construction of a 1 and 2 story factory and administration plant to The Austin Co., 16112 Euclid Ave., Cleveland, O. Estimated cost $1,000,000 including equipment.

Mass., Athol—Union Twist Drill Co., awarded contract for the construction of a 2 story factory to E. J. Gross Co., 82 Foster St., Worcester. Estimated cost $40,000.

Mass., Attleboro—L. G. Balfour & Co., 25 County St., awarded contract for the construction of a power plant for factory on County St., to H. O. MacKinnon & Co., 38 Emery St. Estimated cost $40,000 to $50,000.

Mo., St. Louis—Federal Brilliant Co., 3531 Washington Ave., awarded contract for a 4 story, 33 x 57 ft. sign factory at 3522 Washington Ave., to H. O. Hirsch & Co., Wainwright Bldg.

N. J., Harrison—Driver-Harris Co., Middlesex St., will receive bids about July 15 for the construction of a 1 and 2 story addition to factory for the manufacture of alloys for electrical resistance and castings for bonizing, hardening and tempering. Estimated cost $250,000. J. A. Finegan, 776 Broad St., Newark, is architect.

N. J., Jersey City—B. Singer, 921 Bergen Ave., Archt., will receive bids about July 15 for a 2 story, 45 x 140 ft. factory on Crawford St., for Jersey City Ladder Co., Inc., 677 Montgomery St. Estimated cost $40,000.

N. J., Trenton—Trenton Potteries Co., North Clinton St., will soon award contract for the construction of a 1 story addition to factory. Estimated cost $40,000. Lockwood, Green Engrs. Inc., 100 East 42nd St., New York, N. Y., are architects and engineers.

O., Cleveland—Allied Oil Co., F. R. Newman, Secy. and Treas., 1021 Guardian Bldg., is having plans prepared for the construction of a group of buildings including boiler house, pump house, office, etc., at East 40th St. and Lakeside Ave. Estimated cost $40,000. W. H. Hatch, Hippodrome Annex Bldg., is architect.

Pa., Erie — Metric Metal Works, awarded contract for a 2 and 3 story, 55 x 100 ft. factory to Henry Shenk Co., 12th and Sassafrass Sts. Estimated cost $40,000. Work will be done by owner's forces.

Pa., Marienville — Marienville Glass Bottle Co., R. R. Underwood, Pres., is receiving bids for a 1 story, 100 x 200 ft. glass bottle plant including new equipment. Estimated cost $100,000. Private plans.

Wis., Mayville—Wisconsin Radiator Furniture Co., awarded contract for the construction of a 1 story, 47 x 175 and 60 x 60 ft. factory to Rhode-Kapelle Co., Mayville.

Ont., Hamilton—Grasselli Chemical Co. Ltd., Federal Bldg., Toronto, subsidiary of Canadian Industries, awarded contract for a 1 story, 117 x 240 ft. fertilizer plant to Anglin-Norcross Ltd., Temple Bldg., Toronto. Estimated total cost $200,000.

POWER

With which are consolidated *The Engineer* and the *Stationary Engineer*

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Contents for June 24, 1930

VOLUME 71, NUMBER 25

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Berlin Greets Power Engineers of Many Countries **972**
Delegates, representing world's leading engineering organizations, complete first week's program of the second plenary session of the World Power Conference. BY ELY C. HUTCHINSON

World-Wide Broadcast Feature of N.E.L.A. Meeting **984**
Greatest hook-up in radio history for exchange of messages between New York, San Francisco, London and Berlin.

Automatic Dispatching Improves Elevator Service **986**
Vertical traffic can be most efficiently handled when cars are kept equally spaced in the hoistways. BY F. A. ANNETT

Station A Twenty Years Later **988**
The evolution of power-generating equipment between 1910 and 1930 as seen in a comparison of this Western station's units.

Purchasing Oil on the Basis of Service-Cost **989**
The method adopted by the Navy Department for economical selection of lubricants is applicable to land practice. BY C. A. GRIFFITHS, U.S.N.

Forced-Draft Firing of Pulverized Fuel **991**
BY OLLISON CRAIG

Slide Rule Simplifies Orifice-Flow Calculations **997**
BY H. G. HYLAND

Oil and Gas Engine Problems Discussed at Penn State **1002**

EDITORIALS 970
RIGHT OUT OF THE PLANT 994
AMONG READERS' PROBLEMS 1000
WHAT'S NEW IN PLANT EQUIPMENT . 1004
NEWS OF THE FIELD 1007
NEW PLANT CONSTRUCTION 1012

McGRAW-HILL PUBLISHING COMPANY, INC., Tenth Ave. at 36th St., NEW YORK, N. Y.

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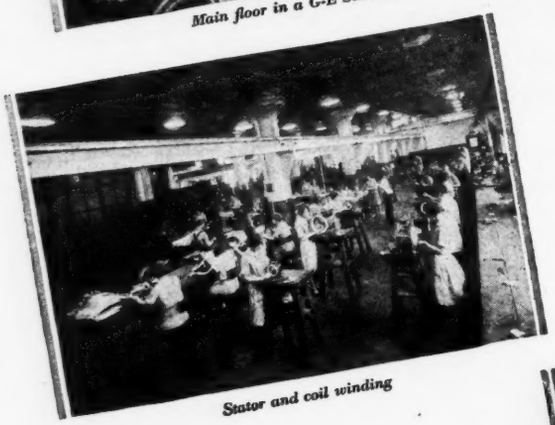
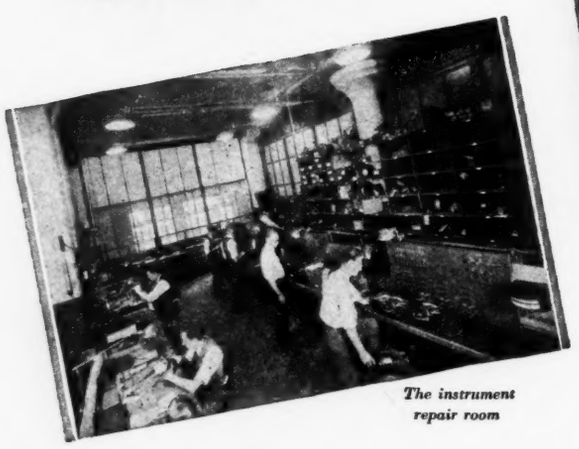
ALL SET
for the repair or rebuilding of electric equipment.

Main floor in a G-E Service Shop



Stator and coil winding



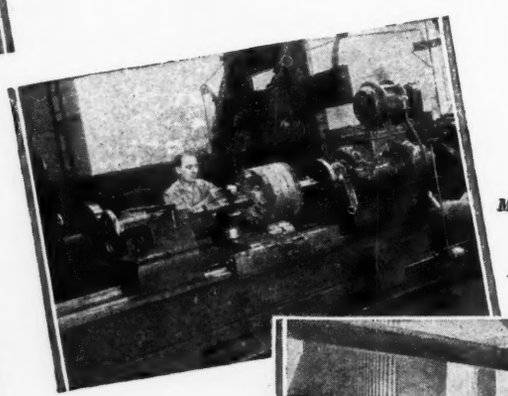
The instrument repair room

WHEN electric equipment requires repair or rebuilding—who will do it right?

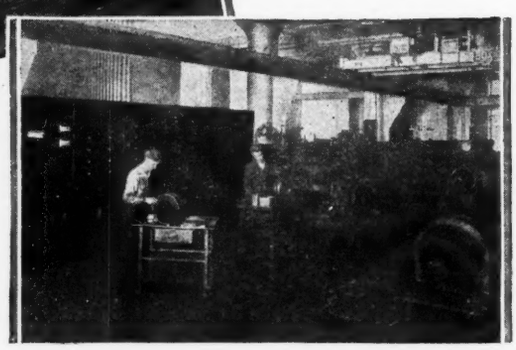
General Electric answers this important question with a service organization maintaining service shops in twenty-two industrial centers—each shop with a highly trained personnel and complete facilities for quick, accurate work on every class of electric equipment.

The illustrations present views in a typical G-E Service Shop. Facilities such as these, and a policy that admits of no deviation from original specifications, provide a service characterized by promptness, accuracy, and factory standards.

General Electric Service Shops, all over the country, are ready, day and night, with men and equipment, to effect rapid, reliable repairs to your electric apparatus —in the shop or upon your own premises.



Mechanical check on motor rotor



Motor-testing department

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91-44

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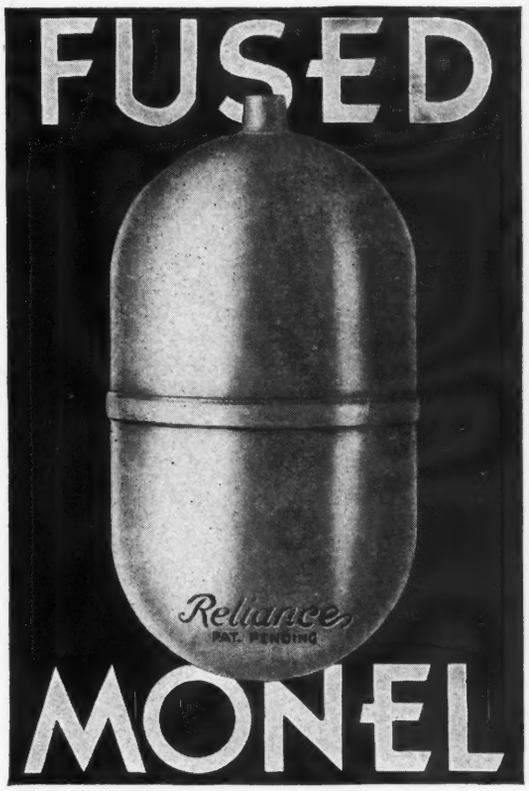
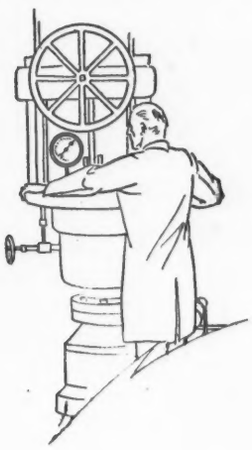
Another 200 Pounds Above Requirements

Fusing the Reliance Float into a solid Monel shell.



Every Reliance Float is tested at twice the pressure at which you will use it.



FIFTY years without a known failure in an emergency—nothing but aggressive Reliance engineering could have made such a record for Reliance Safety Columns.

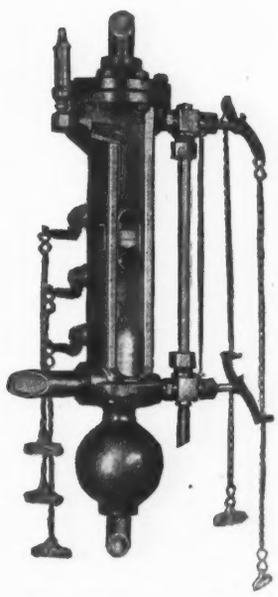
That Reliance will keep this record is evident—from the way margins of safety are being constantly enlarged—safety piled on safety. New materials, new designs, new manufacturing processes.

The new Reliance Float of Monel Metal, for instance. Fused, as it is, by a unique and highly successful process the metal flows together so *there is no joint.* Monel also adds an extra 200 pounds to its structural strength. Reliance Floats now stand under test more than double the pressure they are specified for.

This strength maintains the buoyance that gives Reliance Safety Water Columns their sensitivity, their instant and unfailing response that warns of high or low water levels in your boilers. By no other way is such a reliability of action obtainable.

The Reliance 50-year record will be back of the Reliance Columns you put on guard in your power plant. With 8 out of every 10 safety water columns in use bearing the name Reliance, that means a safety you can depend on. Any pressures up to 750 lbs.

The renewable seat and spring of the Reliance 450 lb. Gauge Cock is also made of Monel Metal. This helps to account for the remarkable efficiency of the Reliance Gauge Cock.



Sectional view of Reliance No. 5 Safety Water Column showing floats and operating mechanism.

THE RELIANCE GAUGE COLUMN COMPANY
5902 Carnegie Ave., Cleveland, Ohio

Reliance

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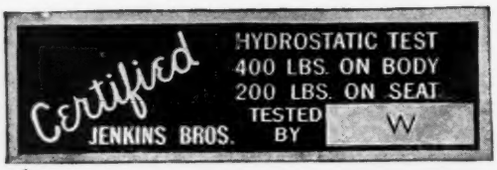
SAFETY WATER COLUMNS



EACH VALVE *carries its own credentials*

RATED pressures for steam, oil, water and gas are cast in the valve body of each Jenkins Iron Body Gate Valve. The "certified" brass plate gives the hydrostatic factory test which each valve has passed.

Every one of these valves is tested, identified, certified. Each is manufactured to the high standard of Jenkins quality which is your assurance of valve satisfaction.

Supply houses everywhere can furnish Jenkins Iron Body Gates, both flanged and screwed, and stocks at convenient points assure prompt delivery.

JENKINS IRON BODY GATE VALVES
SOLID WEDGE . . . BRONZE MOUNTED

Inside Screw, Stationary Spindle; Outside Screw & Yoke, Rising Spindle (Screwed or Flanged)	Rated Working Pressure, Pounds			
	STEAM	OIL	WATER	GAS
Standard	125	200	200	200
Medium	175	300	300	300
Extra Heavy	250	500	500	500

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**Illustrated above is facsimile of certified brass plate carried by Fig. 651, Jenkins Standard Iron Body Gate Valve, rising spindle, illustrated at right* ⟶

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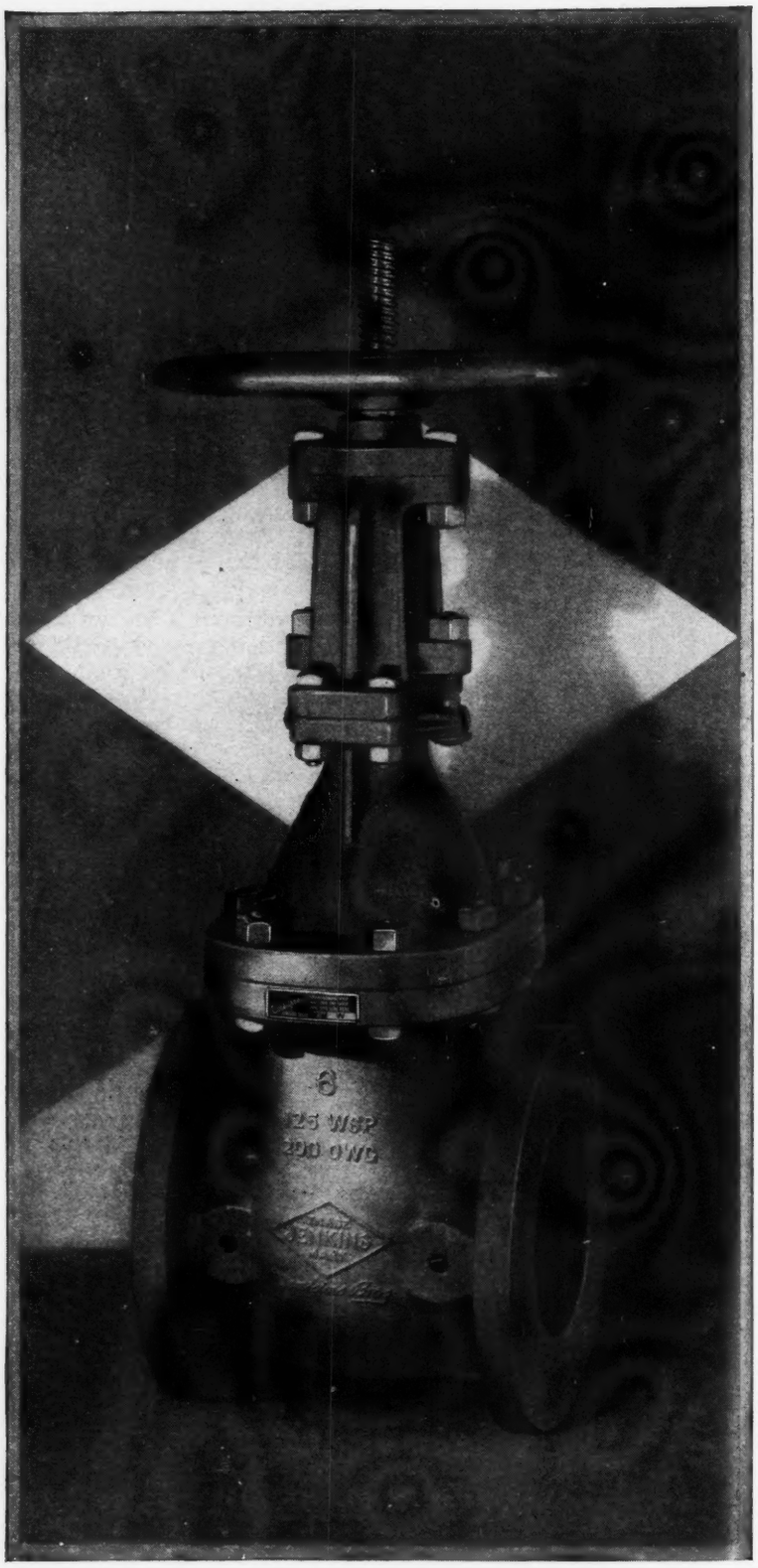
VALVES
Since 1864



COPES CONTROLS BOILER FEEDING IN THIS MILL

The PROBLEM

To provide effective, economical feed water regulation on three 800-horsepower Kidwell boilers operating at a maximum rating of 250 percent and at 375 pounds W.S.P., fed by two turbine-driven Weir centrifugal pumps. Pump pressure was 490 pounds.

The SOLUTION

Each boiler was equipped with a COPES Type BIR Regulator, 400 - pound standard, with cast steel valve body and Monel Metal valve fittings designed for the specific flow conditions. A COPES Type DS Governor was installed in the steam line to each pump.

In this plant (name on request), Nova Scotia's first complete paper-making unit, producing 250 tons of newsprint daily, boiler efficiency is increased by COPES Feed Water Regulators and Pump Governors designed and built for the specific operating conditions.

Digesters in the pulp mill and beaters and paper machines in the paper mill place a fluctuating load on the boilers. Water level must be *stabilized* if steam cost is to be held at a minimum. That means COPES Regulation.

33 paper mills, 25 mining companies, 38 iron and steel mills, 13 sugar mills and 271 other plants have 10 or more COPES Regulators in service. COPES, the pioneer feed water regulator, has proved its ability to handle *any* load condition effectively.

On smaller boilers, COPES Regulation may cost you less than $100 per boiler. May we present facts on COPES at your convenience?

NORTHERN EQUIPMENT COMPANY

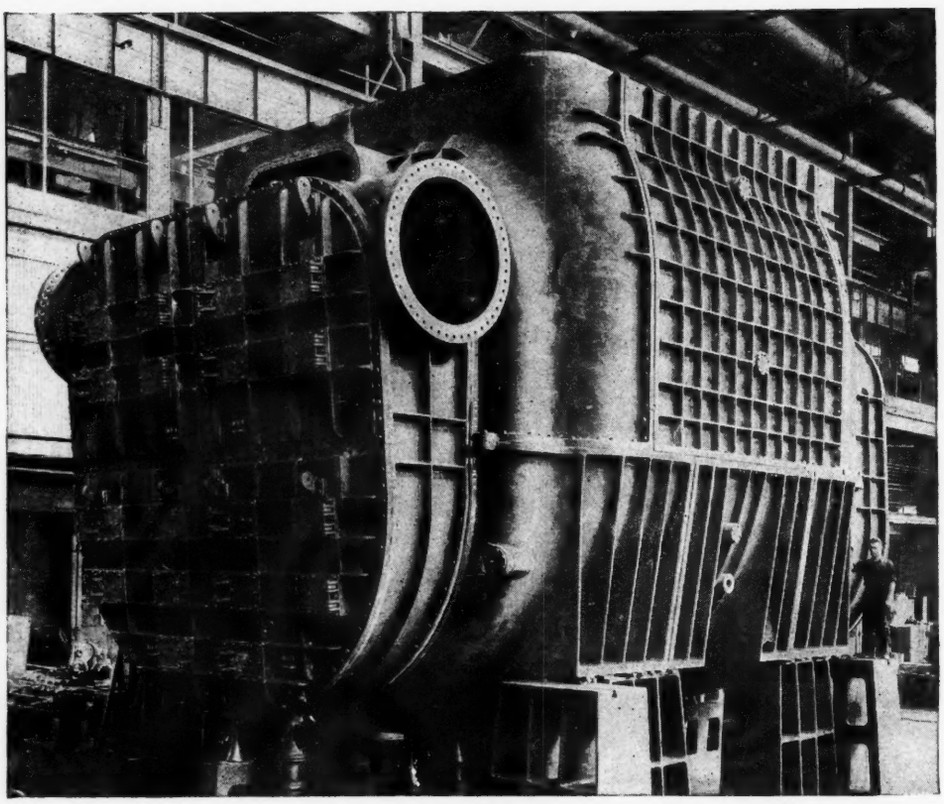
641 Grove Drive, Erie, Pa.

Branch Plants in Canada, England, France, Germany, Austria and Italy. Representatives Everywhere.

COPES

SYSTEM OF BOILER FEED CONTROL

Facilities for the BIGGEST *of them*



88,500-sq. ft. Westinghouse Radial-Flow Condenser, assembled in the shop for water test.

A RADIAL-FLOW surface condenser with 88,500 sq. ft. of surface was recently built at the Westinghouse South Philadelphia Works.

This condenser contains approximately 74 miles of tubes, and weighs 1,500,000 lb. when filled with water for testing.

The design, construction and assembling of such a mammoth condenser requires facilities and equipment of immense size and special design. Every Westinghouse condenser, whether large or small, is designed according to the highest standards of engineering practice and is constructed in well-equipped shops where the best facilities are available.

Service, prompt and efficient, by a coast-to-coast chain of well-equipped shops

Westinghouse

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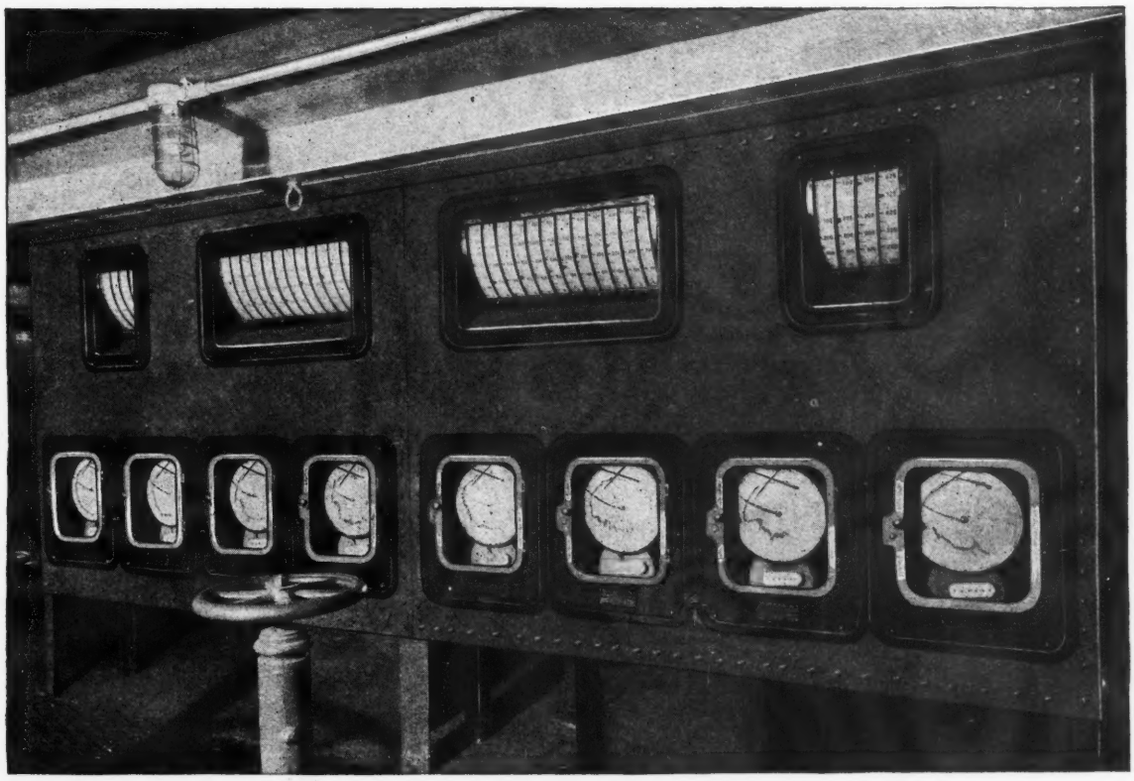
TUNE IN THE WESTINGHOUSE SALUTE OVER THE N. B. C. NATION-WIDE NETWORK EVERY TUESDAY EVENING.



Tightening the Power Harness With Bailey Meters

On Power, that gigantic force harnessed by the ingenuity of modern man, we depend for the convenience, speed and luxuries of our age. Without it civilization would be paralyzed.

By his ever increasing knowledge of physical laws and actual conditions surrounding the generation and use of steam power, man has year after year made his Power harness more complete. In 1920 the overall efficiency from the coal pile to the switchboard in the average steam power plant was only 8%. Today stations are operating with efficiencies as high as 27%.

An accurate knowledge of actual operating conditions as brought to light by dependable metering equipment has played a major part in securing and maintaining these improved efficiencies.

At the Colfax Station of the Duquesne Light Company, Bailey Metering Equipment is used to determine the station's heat balance and to insure economical operation. The Bailey Fluid Meters and Multi-Pointer Gages shown above are used at this station to determine the flow of heat energy in the feed water cycle.

Heat energy is Power which must be harnessed effectively and guided carefully, if a maximum return is to be secured from it. Progressive industrial plants and modern central stations are tightening their Power harnesses and improving the operation of their plants by the use of Bailey Metering, Control and Regulating Equipment.

Write for Bulletin No. 81
"The Heat Balance in Steam Power Plants"

BAILEY METER CO.,
1036 IVANHOE RD. CLEVELAND, O.
Bailey Meter Company Ltd.-Montreal, Canada

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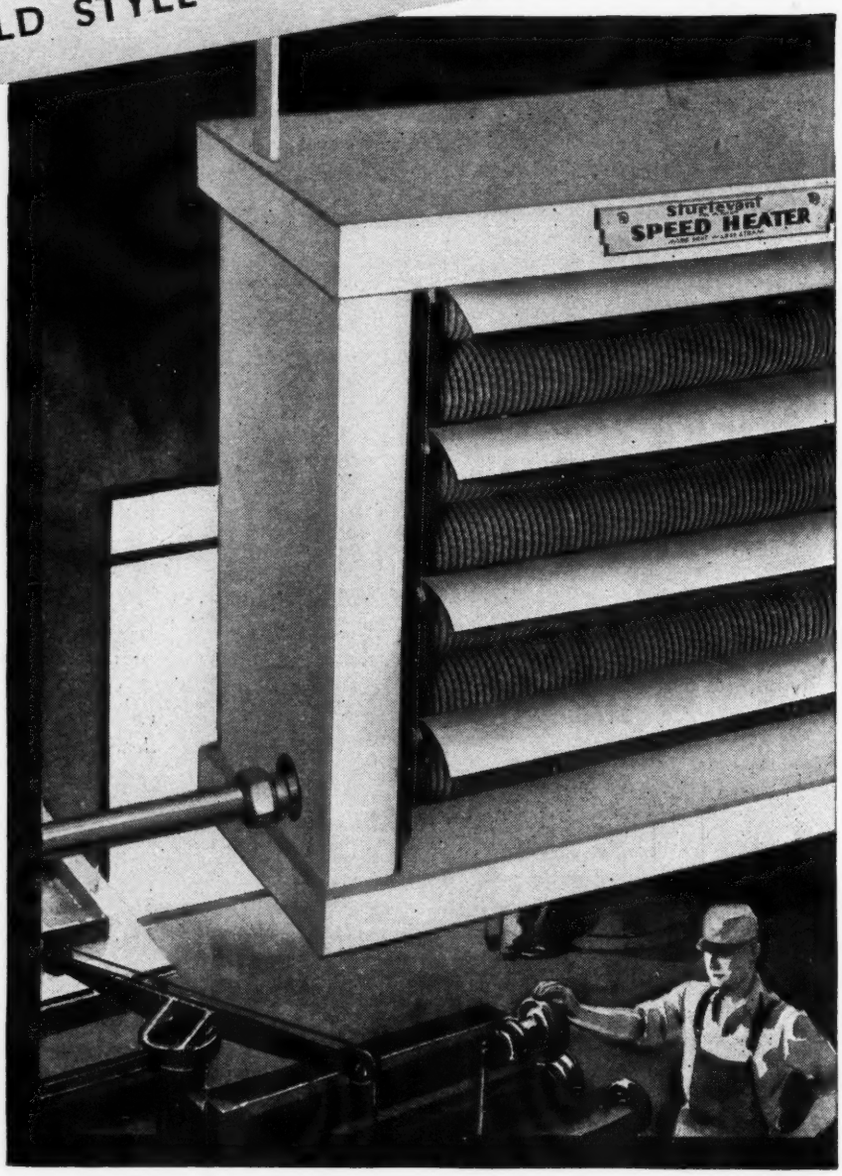
ONE SPEED HEATER
EQUALS FROM ½ TO 3 TONS OF OLD STYLE RADIATION!



ON one hand . . . ½ to 3 tons of old-fashioned cast iron or pipe coil radiation.

On the other hand . . . one compact Speed Heater . . . weighing from 95 to 250 pounds . . . replaces it all!

Imagine the efficiency of Speed Heating . . . the saving in steam . . . and the saving in initial cost of equipment and installation labor!

No heating job is too tough for Speed Heaters. Ceilings may be 30 feet high . . . floor area as large as a farm . . . and swept by drafts. But Speed Heaters will *kill* the cold!

If you're building a new plant . . . adding a wing or floor . . . or merely want more heat at one or two cold spots . . . don't fail to get the facts about the remarkably efficient and money-saving Speed Heater.

The coupon is handy . . . mail it now!

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(REG. U. S. PAT. OFF.)
SPEED HEATERS

A MOUNTAIN OF DIRT REMOVED BY TRACYFIERS

In the plant of the U. S. Metals Refining Co., Carteret, N. J., TRACYFIERS installed in the boilers remove 19 pounds of solids from the steam every hour---think of it! Sixty-six tons a year. Multiply this by the Tracyfiers now installed in boilers aggregating more than three million horsepower---a veritable mountain of dirt is removed by Tracyfiers yearly.

Tracyfiers make but one claim---one guarantee---to remove all dirt and moisture from steam before it can do any harm to your expensive machinery, to render it absolutely clean and dry---savings in maintenance, fuel and lubrication costs follow as surely as death and taxes.

Let us submit complete data on Tracyfiers for your consideration.

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TRACYFIER
THE STEAM PURIFIER

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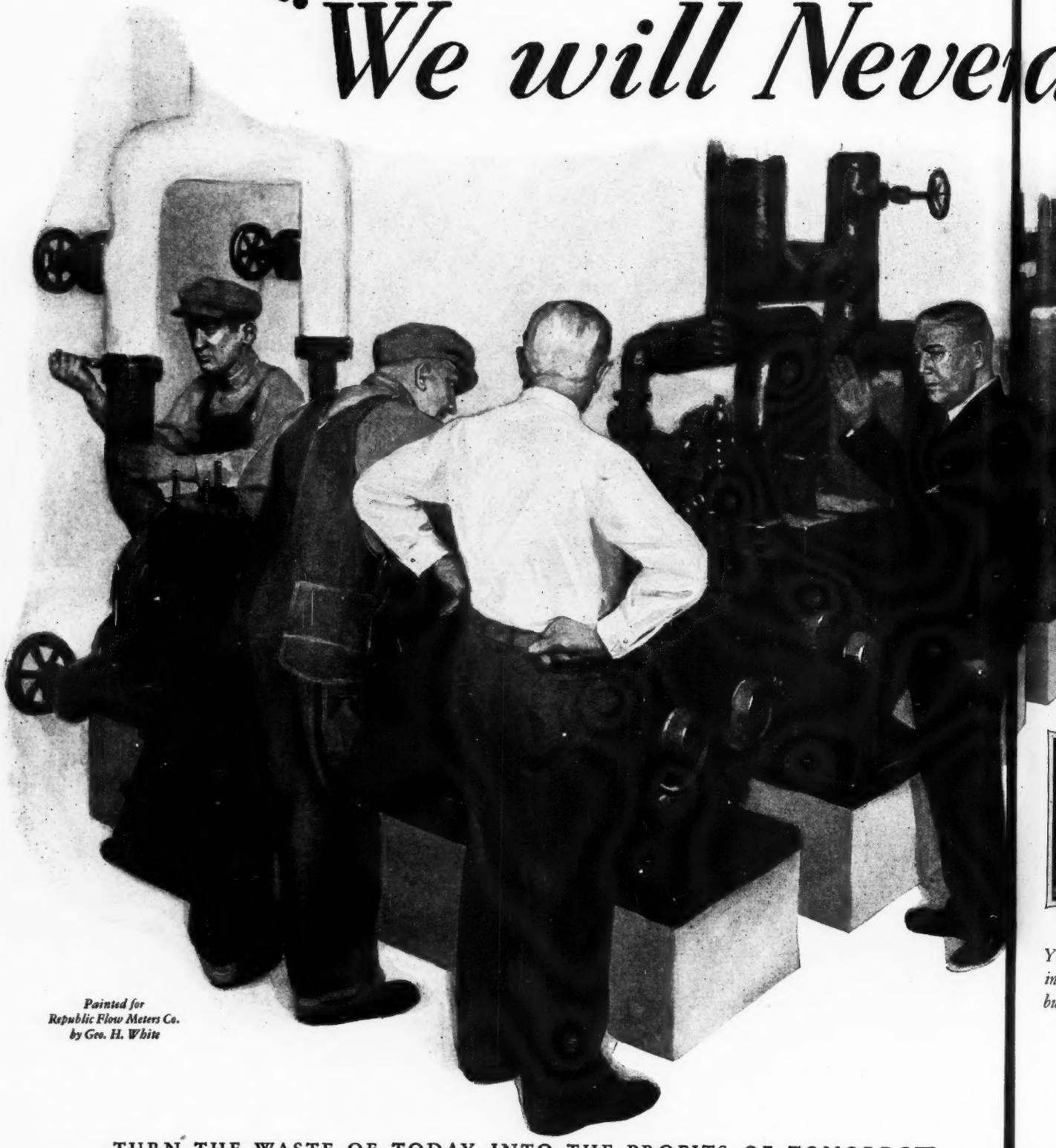
"Solids were being carried over with the steam to our turbo-generator in such quantities as to necessitate shut-down twice a year to clean turbine passages. Since a shut-down is very costly in a cement plant, we were forced to find a remedy. The Tracyfiers have eliminated the trouble and effected a very large yearly saving."

"We will Never



Painted for Republic Flow Meters Co. by Geo. H. White

TURN THE WASTE OF TODAY INTO THE PROFITS OF TOMORROW

REPUBLIC INSTRUMENTS

The REPUBLIC

...do This *Again!*"

You weigh your coal; are you measuring your steam? It is better economy to buy pounds of steam than pounds of coal

"THREE or four days more? Why, man, you have been at this job a week now."

"But we still have the last two pumps to pull down and I don't know what we will run into when we get inside. You see we can only take one pump off the line at a time, and then only during certain hours."

"This sure is a joke. Pull down six pumps to find one that isn't delivering up to capacity. We'll never do this again, if I am on the job—that's a cinch!"

"We wouldn't be doing it now if you had passed that requisition for flow meters on these pumps."

"What do you mean by that?"

"I mean that if we had a flow meter on each of these pumps we would know at all times just what each pump was doing. Here we are spending two weeks to find out something that a flow meter could tell us in two seconds. Think it over!"

Of course, there was only one answer, and so today a battery of Republic Flow Meters is measuring the amount of water delivered by each of the six pumps.

Just why Republic Flow Meters were selected is told in a bulletin entitled "Republic Water Meters".

Write for your copy today

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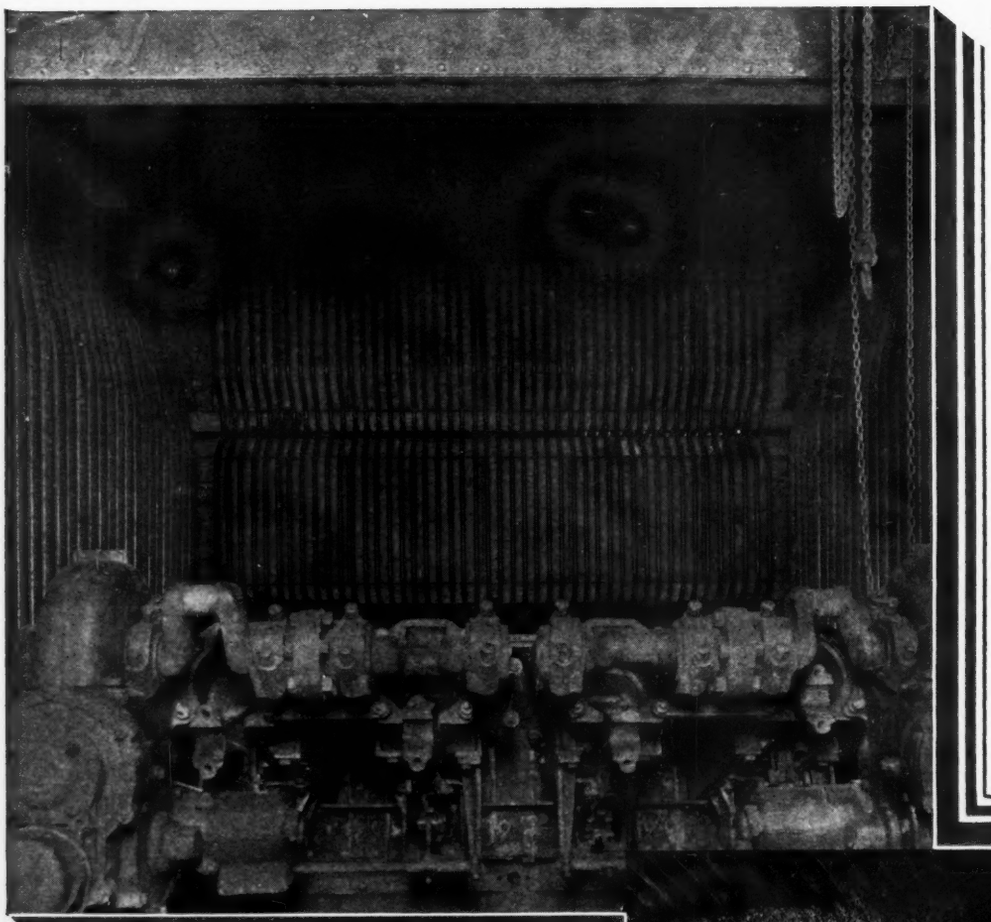
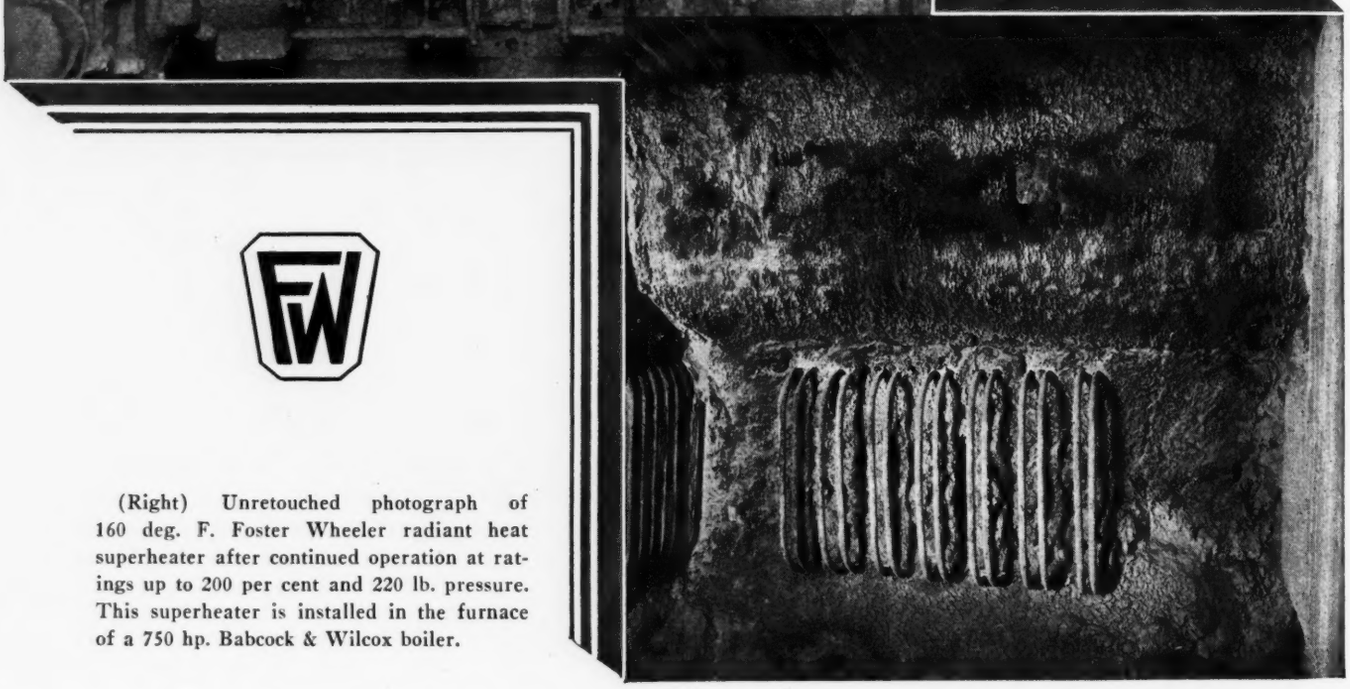
FLOW METERS

REPUBLIC INSTRUMENTS



(Left) Foster Wheeler radiant heat superheater installed in the rear furnace wall of a 1530 hp. Walsh & Weidner stoker fired boiler. The superheater is designed to add 185 deg. F. superheat at normal boiler ratings. Foster Wheeler water walls are shown in each side wall.



(Right) Unretouched photograph of 160 deg. F. Foster Wheeler radiant heat superheater after continued operation at ratings up to 200 per cent and 220 lb. pressure. This superheater is installed in the furnace of a 750 hp. Babcock & Wilcox boiler.

AFRO UNIT COAL PULVERIZERS
AIR HEATERS CENTRIFUGAL PUMPS
CONDENSERS COOLING TOWERS
ECONOMIZERS EVAPORATORS
EXPANSION JOINTS FEED WATER HEATERS

FOSTER

Radiant Heat Superheaters

Alloy steel, round tube Foster Wheeler radiant heat superheaters are shown in the accompanying illustrations.

These superheaters meet certain operating conditions better than any other construction. They are light, compact, inexpensive to install and maintain. Where applicable, they are superior to any design yet developed.

During the past few years nearly 100 Foster Wheeler radiant heat superheaters have been installed. Written testimonials from operators having several years' experience show excellent results and satisfaction.

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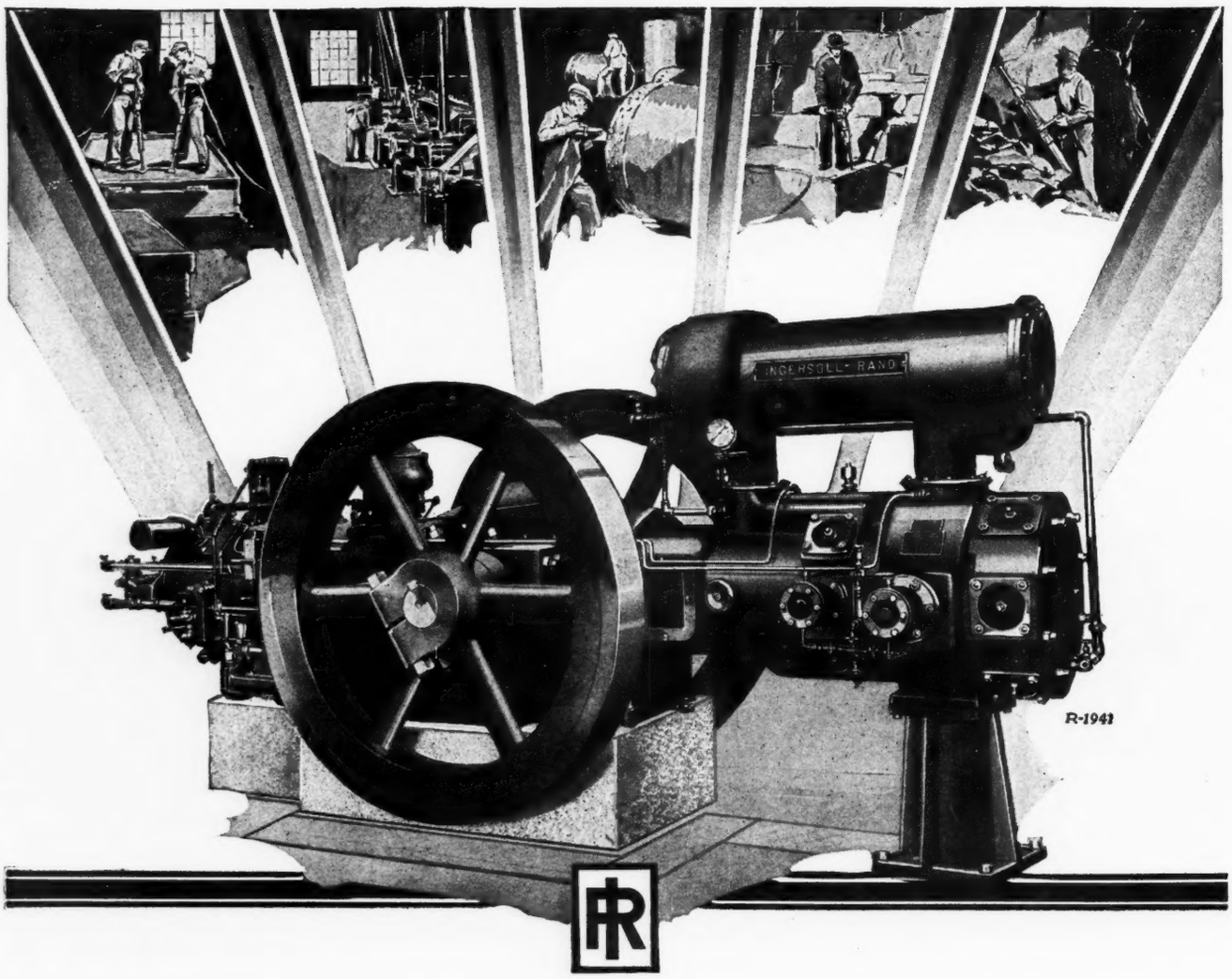
Booster superheater in 1306 hp. Edge Moor boiler. This is one of eight similar Foster Wheeler installations to boost the existing superheat by 100 deg. F.

WHEELER

FRACTIONATING TOWERS HEAT EXCHANGERS
STEAM JET AIR PUMPS SUPERHEATERS
TUBE STILLS VACUUM PUMPS
WATER COOLED FURNACE SURFACES
BRASS AND COPPER TUBING AND PIPE



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Is Direct Connection of the Air Compressor to a Diesel Engine the most economical type of drive?

Because

1—It employs the Diesel Engine, the prime mover giving the greatest overall efficiency particularly in the smaller sizes.

2—Power transmission losses are reduced to the absolute minimum.

Ten Years of Experience with the design have proved that:—

The engineering is sound! The construction is rugged! It gives the lowest operating cost per cu. ft. of air delivered!

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ROLLER MILLS

Dry and Grind Simultaneously

"Two operations in one" describes the performance of the Raymond Roller Mill when grinding coal with high moisture content. By combining the two operations—drying and grinding—dryers, conveyors, and other auxiliary equipment formerly required are eliminated.

Raymond Roller Mills are particularly suited for drying and grinding simultaneously as the hot air is drawn through the grinding zone, where the material is being violently agitated. There is no portion of the grinding zone that is not thoroughly air-swept.

•

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200 Madison Avenue New York, N. Y.

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BOILERS • AIR PREHEATERS • STOKERS • PULVERIZED FUEL EQUIPMENT

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Cleveland Electric Illuminating Co.
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•

Consolidated Gas, Electric Light & Power Co.
Baltimore, Md.

•

Delaware River Mfg. Co.
Penns Grove, N. J.

•

Duke Power Co.
Dukeville, N. C.

•

Du Pont Rayon Co.
Richmond, Va.

•

Du Pont Rayon Co.
Waynesboro, Va.

•

Duquesne Light Co.
Cheswick, Pa.

•

Fraser Paper Co. Ltd.
Madawaska, Maine

•

Gulf States Steel Co.
Alabama City, Ala.

•

Milwaukee Electric Railway & Light Co.
St. Francis, Wis.

•

Montaup Electric Co.
Somerset, Mass.

•

New York Edison Co.
New York, N. Y.

•

New York Steam Corporation
New York, N. Y.

•

Page Steel & Wire Co.
Monessen, Pa.

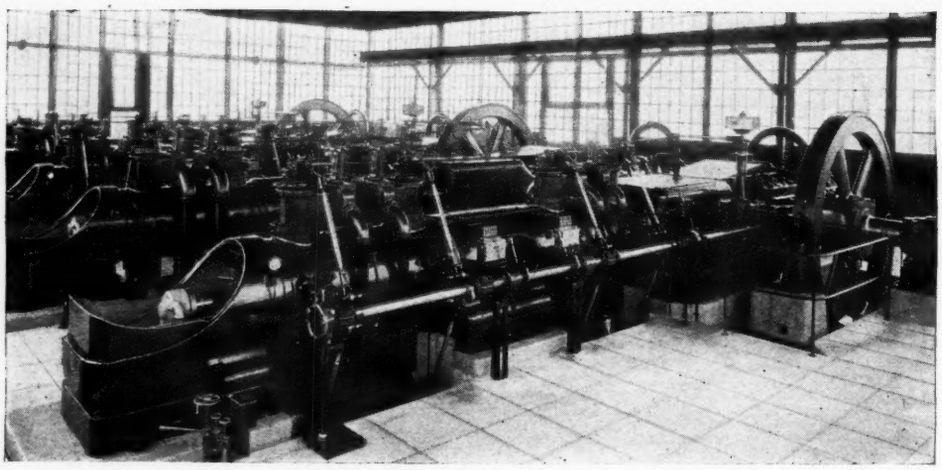
•

Pennsylvania Salt Mfg Co.
Wyandotte, Mich.

•

Sioux City Gas & Electric Co.
Sioux City, Iowa

Worthington Gas-engine-driven Gas Compressors in the Guthrie, La., Station of the Memphis Natural Gas Company on the Monroe-Memphis Pipe Line. Installed by A. M. Lockett & Company under contract from Ford, Bacon & Davis.



7 facts . . . *about* Worthington Gas Engine Compressors

IN this day of booming natural gas projects, it is interesting to consider seven pertinent facts regarding Worthington Gas-engine-driven Gas Compressors:

1. Worthington is the oldest builder of gas engines in the United States. The first unit of this type of equipment was built for the Columbia Natural Gas Company in 1900.
2. Worthington gas engines now installed total close to 400,000 horsepower.
3. During the last four years, Worthington has furnished more than 100,000 horsepower in gas-engine-driven compressors for the natural gas pipe lines.
4. Over 50% of the gas-engine-driven gas compressors now in service are Worthingtons.
5. The low maintenance cost in Worthington-equipped compressor stations is a factor well-known throughout the natural gas industry. This is the result of good substantial design and careful workmanship, reflected in the ability to carry full load without effort.
6. Because of Worthington's established reputation for leadership in this field, prominent pipe line companies have felt justified in paying a higher price for Worthington Compressors than for competitive equipment.
7. Worthington, in collaboration with its associates, A. M. Lockett & Company, New Orleans, La., is in a position to build and equip modern compressor stations, complete in every detail.

Your inquiries are invited. *Ask for Bulletin S-550-B1.*

PUMPS
COMPRESSORS
Stationary and Portable
CONDENSERS
and Auxiliaries
DIESEL ENGINES
GAS ENGINES
FEEDWATER HEATERS
WATER, OIL and
GASOLINE METERS
MULTI-V-DRIVES
CHROMIUM PLATING

Literature on request

WORTHINGTON

EGR-6

WORTHINGTON PUMP AND MACHINERY CORPORATION

Works: Harrison, N. J. Cincinnati, Ohio Buffalo, N.Y. Holyoke, Mass.

Executive Offices: 2 Park Avenue, New York, N.Y.

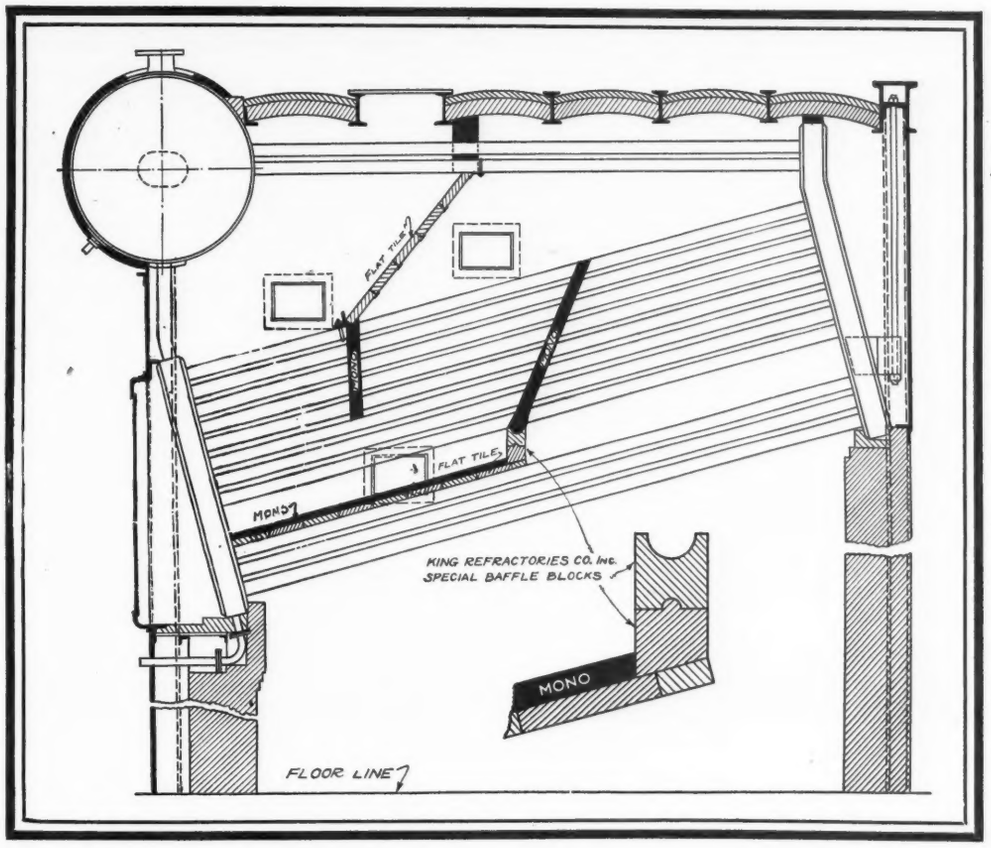
GENERAL OFFICES: HARRISON, N. J.

District Sales Offices and Representatives:

ATLANTA	CHICAGO	DALLAS	EL PASO	LOS ANGELES	PHILADELPHIA	ST. PAUL	SEATTLE
BOSTON	CINCINNATI	DENVER	HOUSTON	NEW ORLEANS	PITTSBURGH	SALT LAKE CITY	TULSA
BUFFALO	CLEVELAND	DETROIT	KANSAS CITY	NEW YORK	ST. LOUIS	SAN FRANCISCO	WASHINGTON

Branch Offices or Representatives in Principal Cities of all Foreign Countries

King Gas-Tight Baffle Blocks Flexibly Join "MONO" Boiler Baffles



THESE special "MONO" Baffle Blocks provide a tongue and groove joint at the juncture of the vertical and horizontal baffles in interdeck boilers of the drop leg type. They permit a slight rocking movement between the baffles due to expansion and keep this baffle juncture lastingly gas tight. The blocks are shaped to allow them to be installed at any angle. The highly refractory material is light in weight, but extremely durable under all temperatures up to 3100 deg.

The illustration shows a typical application. The vertical portion of the baffling is the usual "MONO" Baffle construction whereas the horizontal portion is built up with standard flat tile, floated over with "MONO" Baffle Cement that seals all joints gas tight.

Plant owners and engineers are invited to investigate the building of stronger, more flexible and tighter boiler settings with "FLAME BRAND" HIGH TEMPERATURE REFRACTORIES. Write us today for free instruction book.

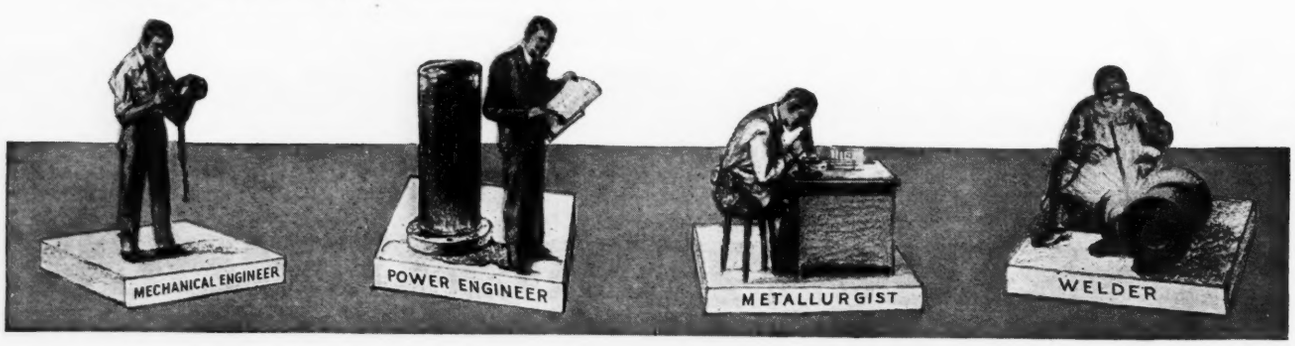
King REFRACTORIES COMPANY
BUFFALO, NEW YORK

MANY American plants right now are planning to modernize with super power to earn new profits.

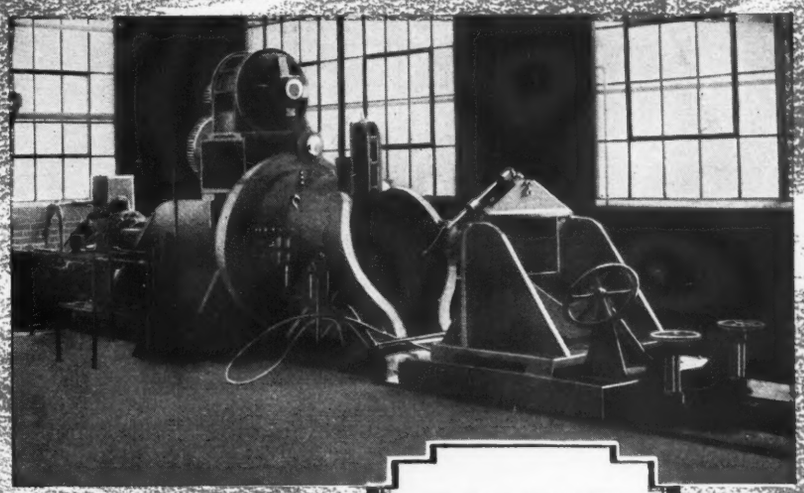
The savings will usually return the cost in a few years. Like many others you may prefer to modernize out of savings, on a deferred payment basis. A packing company saves $50,000 a year for instance. A paper mill $110,000 a year. These savings represent from 25% to 35% on the total cost of modernization.

In piping the terrific steam pressures of Super Power, the chief problem is in the joints. No pipe line is stronger than its joints.

Grinnell has mastered this problem by designing and building an entirely new and different type of machine for making lap joints. (See picture above) Employing hydraulic pressure of over 100,000 pounds, this machine upsets an end of pipe to double the thickness of the pipe. This is done without changing the metal structure.



SUPER POWER



TRIPLE XXX PRODUCTS

The economy and production results you count on, through modernization, are not a matter merely of new boilers and firing methods. Nor of blue-print layouts. Correct interpretation of these layouts, backed by practical engineering knowledge, must be added to get the *final* results.

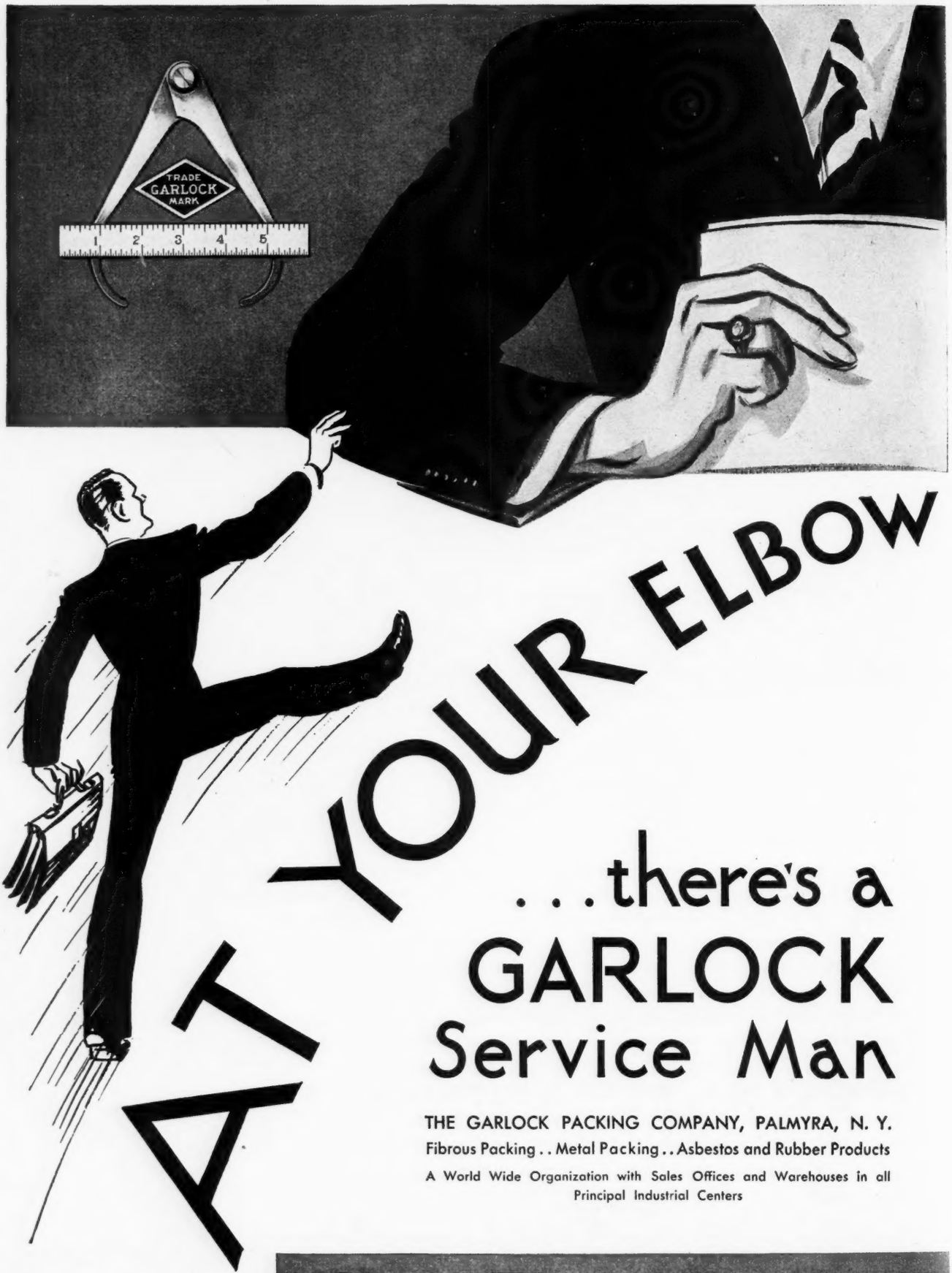
Furthermore, capital investment demands the longest life and the highest efficiency in the piping. Maintenance economies and later additions demand all the scientific knowledge and experience which is built into Triple XXX products. Grinnell lap-joints, welded headers and universal I-beam clamps of forged steel are all Triple XXX quality.

Among the many great concerns using this Grinnell line in super power work are:

American Steel and Wire Company. Carnegie Steel Company. The Youngstown Sheet & Tube Company. American Tobacco Company. American Bemberg Corporation. American Glanzstoff Corporation. Cannon Mills Company. Louisiana Power & Light Company. Alabama Power Company. United Fruit Company. Standard Oil Co. of N. J. Gulf Refining Company. West Virginia Pulp and Paper Company.

GRINNELL TRIPLE XXX PRODUCTS

Grinnell Company, Executive Offices: Providence, R. I. ***Branches in all Principal Cities.***



AT YOUR ELBOW

...there's a
GARLOCK
Service Man

THE GARLOCK PACKING COMPANY, PALMYRA, N. Y.
Fibrous Packing . . Metal Packing . . Asbestos and Rubber Products
A World Wide Organization with Sales Offices and Warehouses in all Principal Industrial Centers

GARLOCK

Keeps boilers on the line longer

Shutting down a boiler for lining and wall repairs is a two-way expense. It means a boiler not producing and money spent for material and labor.

You can double—even treble—the time between these costly occasions if you'll use Betson's PLASTIC FIRE BRICK

Lining this way means you have no fire bricks to spall, crack, and fall out—no bonds to fall away and loosen bricks—no crumbling walls. A Betson lining is a one piece lining, quickly and easily applied completely, throughout. The plastic mass is pounded into place—vitrifies at 900°F. and more. It stays put—does not crack or fall out—puts an end to lining worries.

Write for details.

BETSON'S
ONE PIECE PERMANENT BAFFLES

Betson Tapered baffles increase the efficiency of water tube boilers.

Ordinary straight baffles are inefficient—cannot be gas-tight.

Betson Baffles are quickly made—placed where combustion efficiency dictates. Formed of Plastic Fire Brick they are air-tight—cannot crumble or fall out. They pay dividends in fuel saved and increased efficiency.

Write for details.

BETSON PLASTIC FIRE BRICK CO., INC., 822 East Delavan Ave. BUFFALO, N. Y., U. S. A.

Betson Plastic Fire Brick Co., Inc.
822 East Delavan Ave.,
Buffalo, N. Y.

Gentlemen:

Please send us the booklet "Furnace Linings"

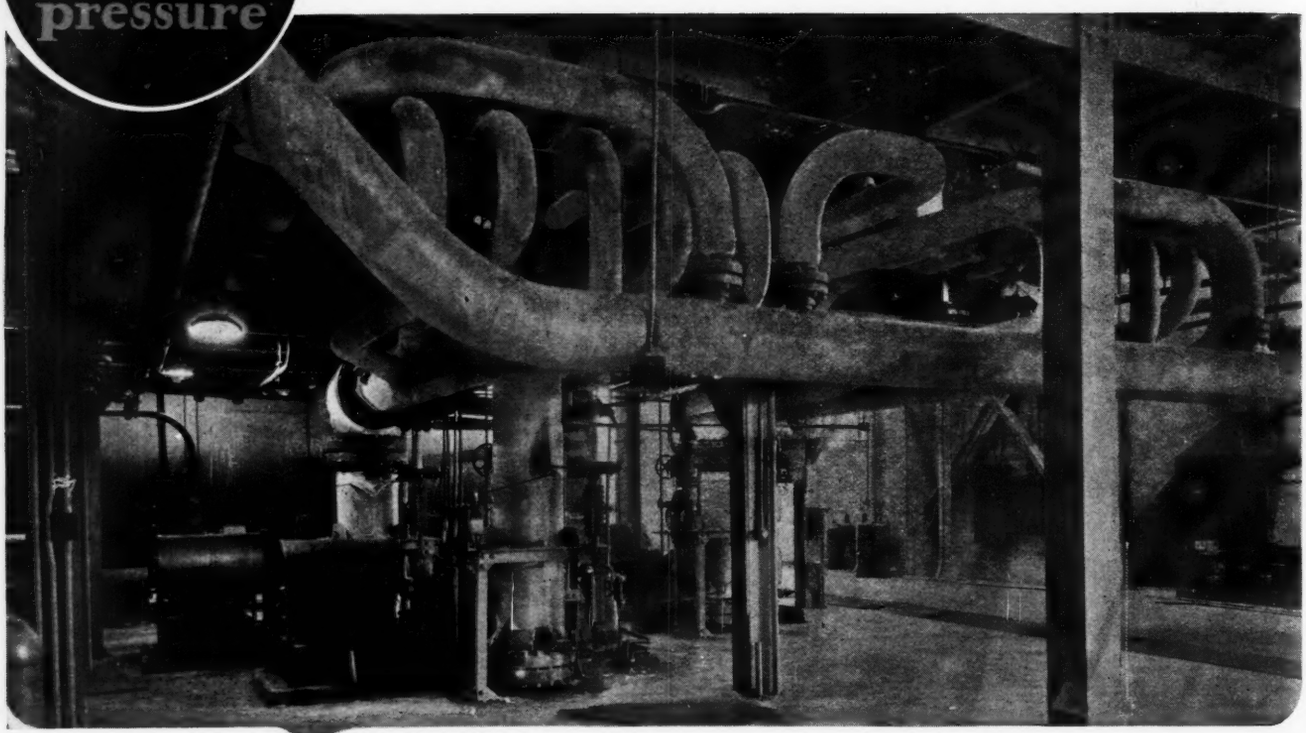
Also send us literature on Betson's "Hi-Heat Cement"—and Betson's One Piece Permanent Baffles—as formed from Betson Plastic Fire Brick.

Name .....

Company .....

Address .....

1350 pounds pressure



DEEPWATER CENTRAL STATION

all piping fabricated and installed

BY "SHAWCO"

Deepwater Station, Deepwater, N. J., Allied Engineers, Inc., New York City, Engineers and Constructors for United Gas Improvement Co. and American Gas & Electric Co.

This tremendous testimony to modern high pressure engineering is a signal achievement.

The entire piping contract was fabricated, installed and tested by the "Shawco" organization, to the entire satisfaction of the plant owners and engineers. Over half a million dollars worth of Shawco Piping Equipment is installed in this plant.

We are set up to do a thorough job on piping of all kinds, for any utility or industrial conditions and for any pressure and service.

We welcome discussion on any or all of your piping problems.

BENJAMIN F. SHAW CO.

WILMINGTON, DELAWARE

Industrials Depend on Bailey Furnace Walls

IT'S a pretty serious matter . . . costly as well as annoying . . . when a boiler has to be taken off the line for furnace repairs. It is also costly to allow for such outage in the initial design of the plant.

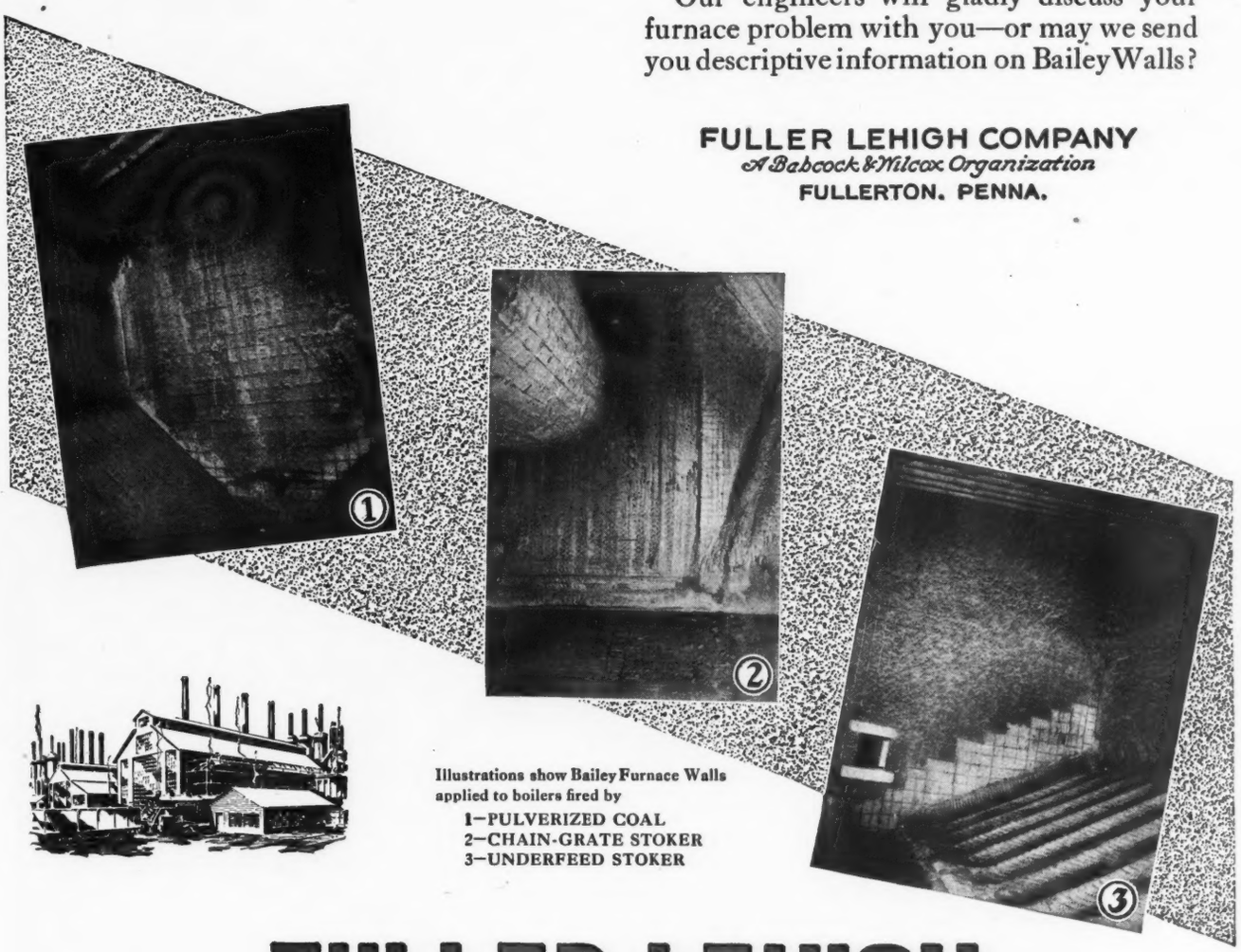
That's one good reason why executives and engineers of industrial boiler plants specify Bailey Water-Cooled Furnace Walls . . . they want higher boiler capacity, availability, efficiency and low maintenance over a wide range of boiler output.

Another important advantage of Bailey Furnace Construction is its flexibility of design. It is available for every type of furnace—with any method of firing—pulverized-coal—stoker—oil—gas.

Last year 40 per cent of all orders for Bailey Walls were repeat installations . . . isn't that conclusive proof of their satisfactory performance?

Our engineers will gladly discuss your furnace problem with you—or may we send you descriptive information on Bailey Walls?

FULLER LEHIGH COMPANY
A Babcock & Wilcox Organization
FULLERTON, PENNA.



Illustrations show Bailey Furnace Walls applied to boilers fired by
1—PULVERIZED COAL
2—CHAIN-GRATE STOKER
3—UNDERFEED STOKER

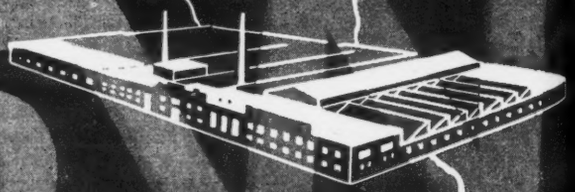
FULLER LEHIGH

PULVERIZED-COAL EQUIPMENT ~ WATER-COOLED FURNACE WALLS

186

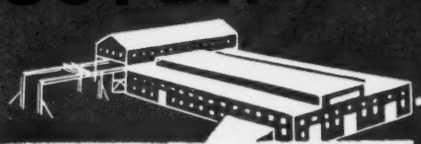
THE SOUTHWEST can now have its piping fabricated at home

LOS ANGELES



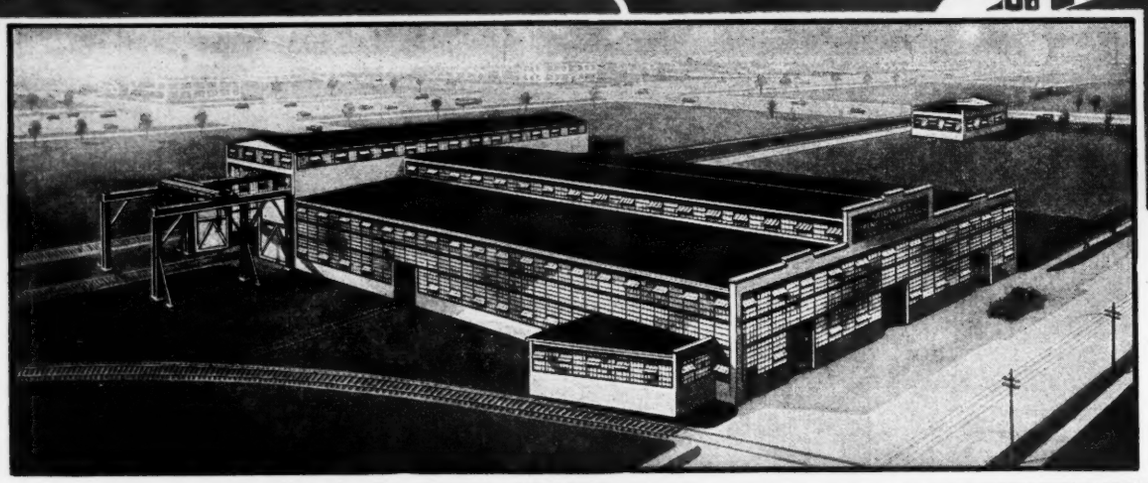
ST. LOUIS

HOUSTON

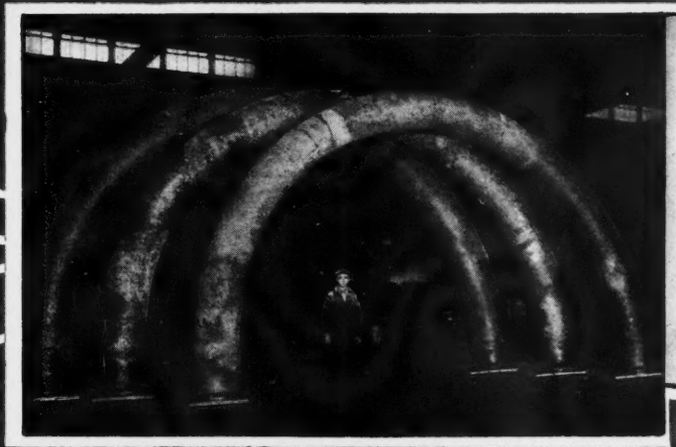


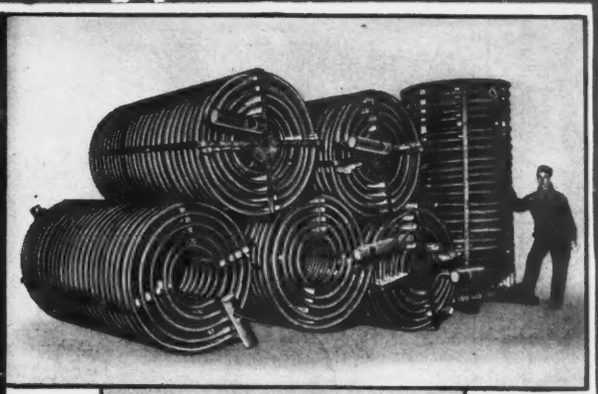
★

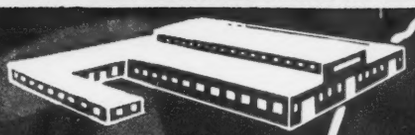
The combined pipe fabricating capacity of the four Midwest plants far exceeds that of any other organization in the country.



THE GREATER MIDWEST







PASSAIC

The new Houston plant of Midwest is prepared to fabricate the piping that is required by the Southwest—complete piping for oil refineries, central stations and industrial plants—individual pipe bends, welded headers and pipe coils.

The Houston plant is similar to the other three plants—it has the same modern facilities, the same efficient practices and the same conception of service—characteristics that have brought Midwest from an humble beginning ten years ago to a position of leadership in the pipe fabricating industry today.

And the key men in the Houston organization were drawn from the other Midwest plants.

Users of fabricated piping in the East, the Middlewest and on the Pacific Coast also benefit from the addition of the Houston plant, for it enables all the Midwest plants to offer the obvious advantages and economies of operating on an even larger scale.*

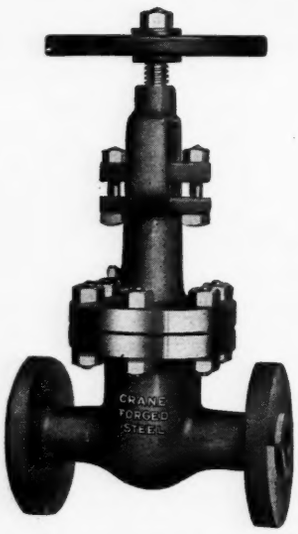
It is now more advantageous than ever before to get in touch with the nearest Midwest office when fabricated piping is required.

MIDWEST PIPING & SUPPLY COMPANY, INC.

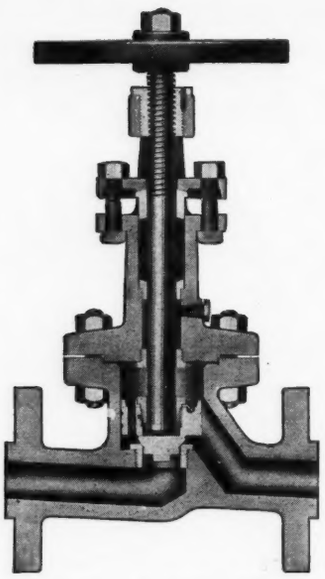
MAIN OFFICE—1450 So. Second St., St. Louis

Chicago,	Los Angeles,	Houston,	Tulsa,	New York,
208 S. La Salle St.	520 N. Anderson St.	600 Bringhurst St.	733 Mayo Building	(Ballwood Division), 30 Church St.

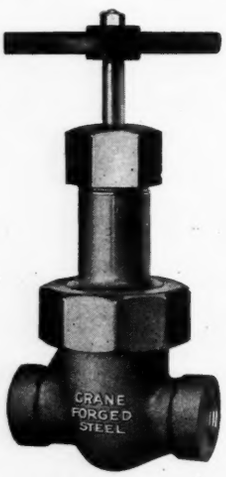
PIPING SERVICE



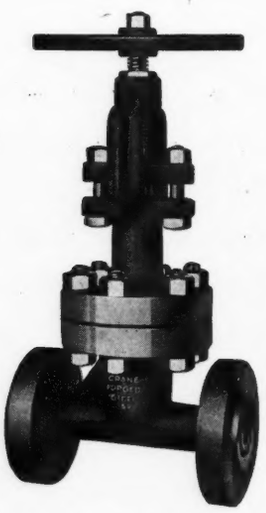
Forged steel gate valve 79-XN. For 600 pounds working pressure at 750° F. Disc for steam service, nitralloy; seats exelloy. Flanged end.



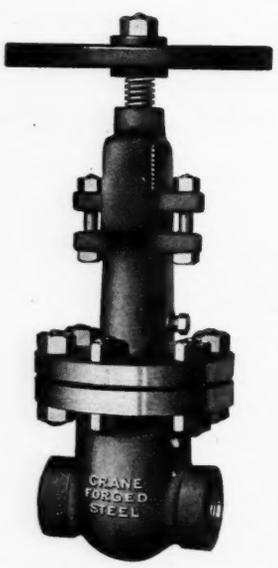
Section of forged steel globe valve 196-XN. For 600 pounds at 750° F. Flanged end. Guided disc nitralloy; seat exelloy.



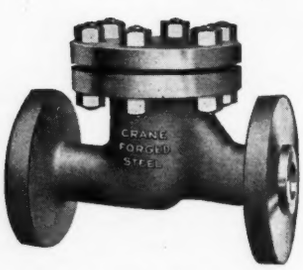
Forged steel globe valve No. 206-X. Union bonnet, exelloy trimmings. For 3000 pounds cold water working pressures.



Forged steel globe valve No. 189-XN. For 1500 pounds working pressure with temperature at 750° F. Disc for steam service, nitralloy; seat exelloy.



Forged steel gate valve 80-XN. For 900 pounds working pressure at 750° F Disc for steam service, nitralloy; seats exelloy. Screwed end.



Forged steel horizontal check valve No. 198-X. For steam or hot oil working pressures of 600 pounds at 750° F. Flanged end, piston type disc, bolted bonnet, exelloy trimmings.

Uniformity

1855
SEVENTY-FIFTH
ANNIVERSARY
1930

Fine steel thoroughly worked to give unusual density and freedom from sponginess, valve walls uniform in thickness . . . among many superior points that experience has given to Crane forged steel valves, perhaps first should come *uniformity*.

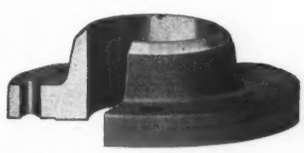
One valve exactly like another in materials and engineering, reduction of all elements of chance to the minimum . . . where are these factors of more importance to safety and saving than under exacting, critical high pressure and superheat conditions?

To uniformity, add also such merits as these: every principal feature of design belongs exclusively to Crane Co.; discs and seats are of metals specially developed by Crane Co. for this service and exhaustively tested for galling; special construction gives an absolutely tight fit of disc against seat; all parts are interchangeable. . . .

But let our specialists on valve engineering and piping materials, stationed for your convenience at strategic points throughout the country, tell you all the improvements that have gone into this superfine line of valves and fittings. Let them give you the ratings and help you select the most economical materials for your needs. On request, these men are also ready to advise about layout.

Forged steel union, No. 246-H. Steel to monel metal seat. Steel union ring. Ground joint. No gasket required. For 900 pounds at 750° F.

Series 15 forged steel flange with welding neck, No. 568. For pressures of 150 pounds at 500° F.



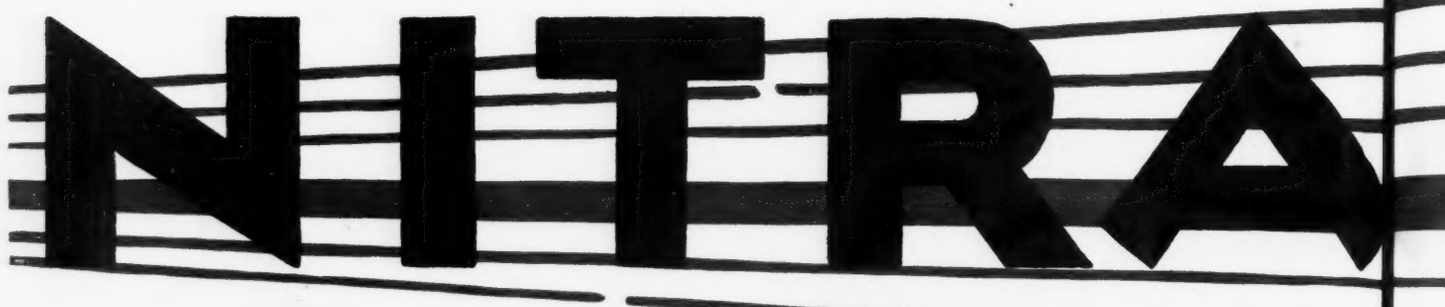
Forged steel flange with welding neck, No. 296-E. Series 30 for 300 pounds pressure at 750° F.

CRANE

PIPING MATERIALS TO CONVEY AND CONTROL STEAM, LIQUIDS, OIL, GAS, CHEMICALS

CRANE CO., GENERAL OFFICES: 836 S. MICHIGAN AVENUE, CHICAGO
NEW YORK OFFICES: 23 W. 44TH STREET
Branches and Sales Offices in One Hundred and Ninety-four Cities

. . . defying the
erosive action
of superheated steam and hot



The modern Valve Trim is

Hardness as interpreted at the present time is a very indefinite subject. In order to discuss this subject intelligently, it is first necessary to determine what is "hardness." During the past few years we have gone over various papers presented on hardness and hardness testing and we believe that the best definition of hardness is as follows: "By hardness is meant that property of mechanical resistance that is possessed by the outer layer of solid bodies."

The surface hardness imparted to steel by the NITRIDING process will scratch glass with ease. Special testing files are worn smooth without effect on this extremely hard surface. Wear tests or abrasion tests made on these hard steels have shown them to be unapproached by any other steel in resistance to wear from the erosive action of superheated steam or hot oil vapors.

The nitrided case extends into the body for a distance of 1/32 in. and merges into the tough core of the special steel. Even with working temperatures at 1200 deg. F. its hardness is not appreciably impaired. NITRALLOY seating surfaces do not seize or gall. Their use means a tight seating valve with practically no attention during years in difficult service.

For full details of NITRALLOY for valve trim, write for descriptive pamphlet today.

Produced by

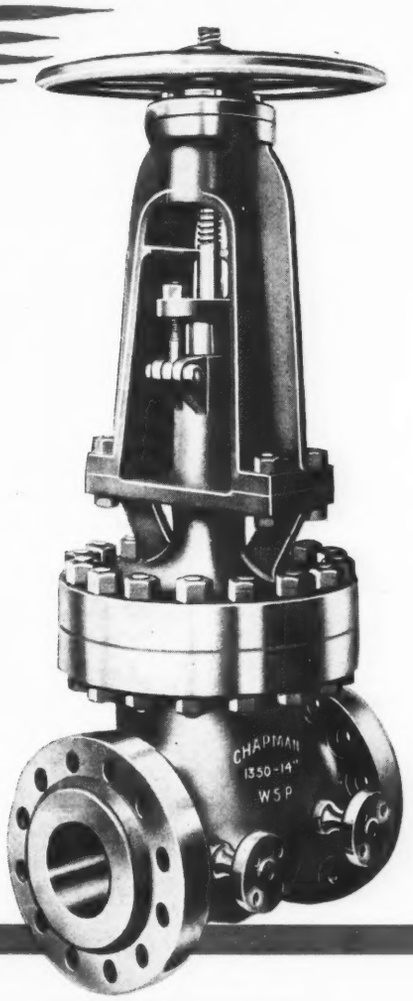
CHAPMAN

For Extreme Valve

oil vapors

LOY

HARD



A Few Typical Users of Chapman Chrome Nickel Steel Valves

Stone & Webster Engineering Corporation
Southern California Edison Company
Puget Sound Power & Light Company
Louisiana Steam Products Company
Lever Brothers Company

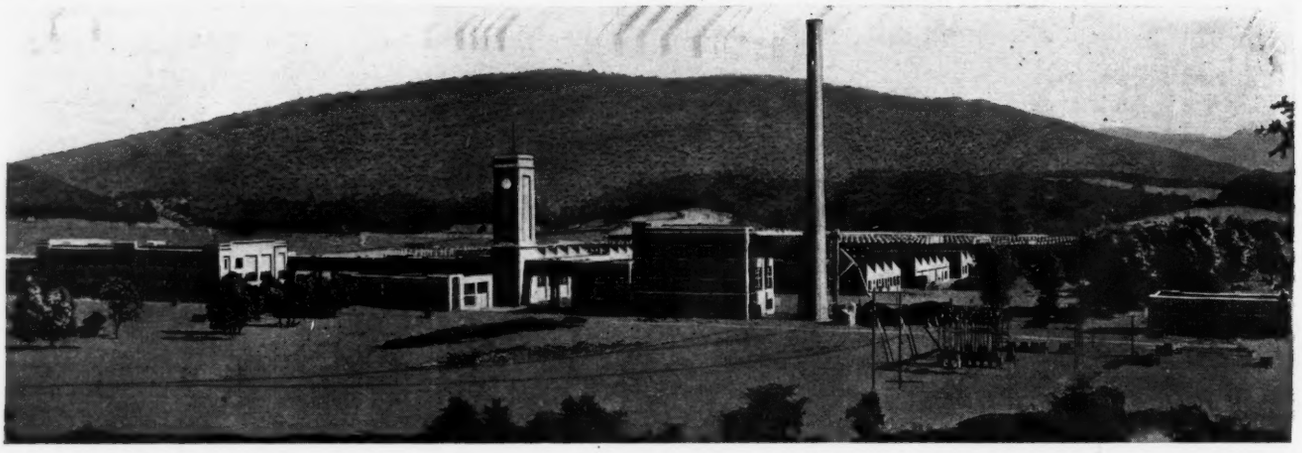
The Chapman Valve Manufacturing Company
Indian Orchard, Massachusetts

BRANCHES:

New York	Cleveland	Chicago	Los Angeles
Detroit	Tulsa	Philadelphia	Syracuse
San Francisco	Pittsburgh	Houston	Atlanta
Boston			

Durability

Insured by STOCKHAM



THE AMERICAN ENKA CORPORATION

IN great industries, insurance against loss by fire and other hazards is vital. But there are still other kinds of insurance which the wise industrialist uses to protect continuous production and profits.

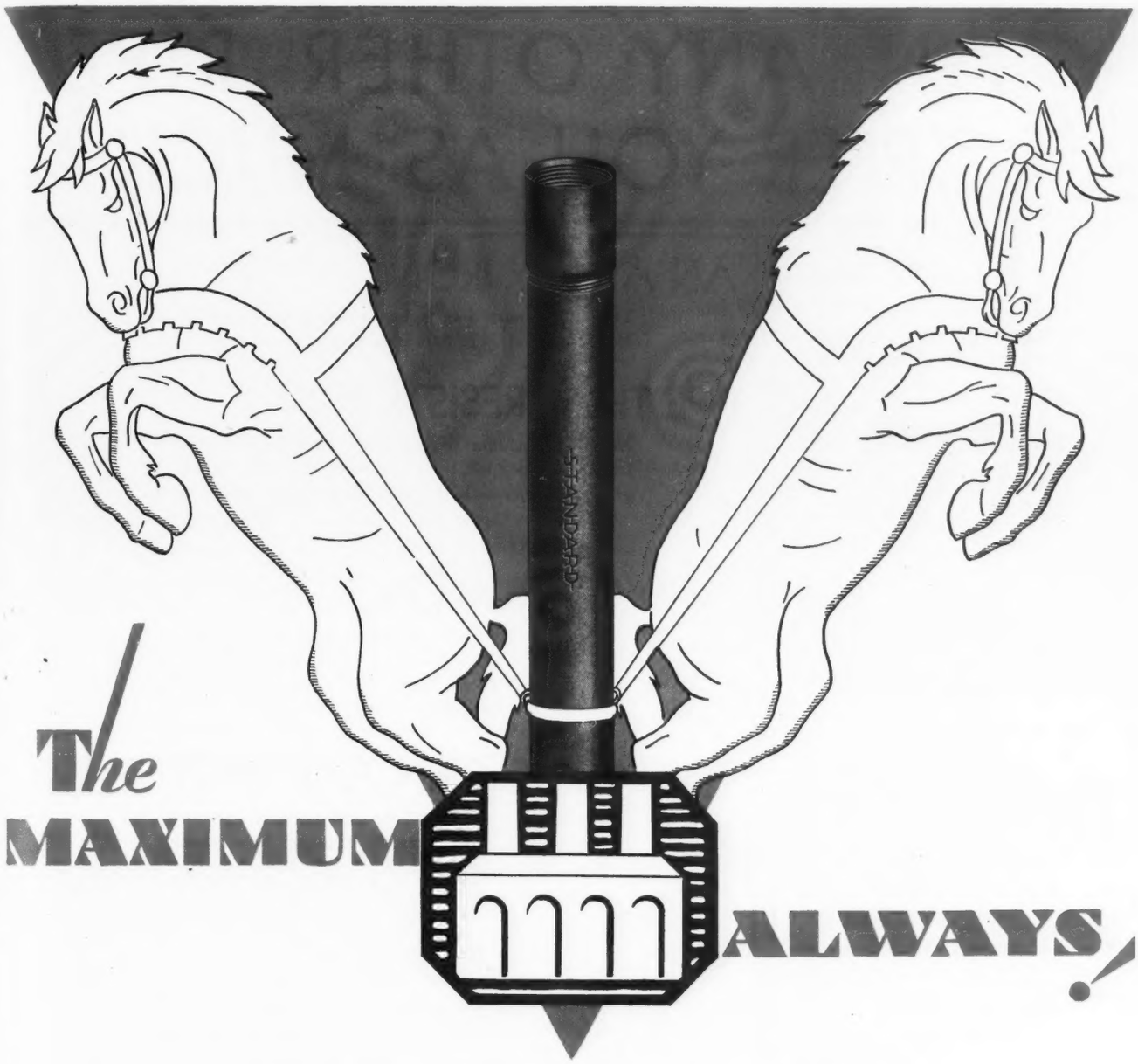
For pipe lines, insurance takes the form of careful selection of pipe fittings. Like the American Enka Corporation, many great concerns select Stockham Fittings to guard against pipe line trouble. Accurately squared and tapped to make straight lines; perfect threads; extra body thickness for extra strength; every Stockham Fitting goes on easily to form tight, leakproof joints and to stand the stress of long service.

The $10,000,000 Rayon plant of the American Enka Corporation is near Asheville, N. C., and was erected by The H. K. Ferguson Co., of Cleveland. Lockwood Greene Engineers, Inc., New York, were consulting engineers. Stockham Fittings were furnished by Ford & Kendig, Philadelphia, and Noland Co., Inc., Spartanburg, S. C. Huffman Wolfe Co., of Philadelphia, were Heating Contractors and E. B. Wright, of Asheville, N. C., the Plumbing Contractor.

STOCKHAM PIPE & FITTINGS CO., ***Birmingham, Ala.***

Stocks in Boston, New York, Chicago, Houston, Los Angeles.

CAST IRON	ELECTRIC CAST STEEL	MALLEABLE
Screwed—Flanged—Drainage—Sprinkler	*Screwed—Flanged*	*Standard—Extra Heavy—Hydraulic—Oil Country*



The MAXIMUM ALWAYS!

Behind the super-power of many modern power plants is the super-strength of "Standard" Seamless Power Piping —securely harnessing the powers of thousands of steam horses—safely guarding the pent up force of super-heated steam and sending it to the tasks of industry.

"Standard" Seamless is nationally distributed and readily available in any size, dimension or standard specification.

SPANG, CHALFANT & CO., INC.

General Offices: CLARK BUILDING, PITTSBURGH, PA.

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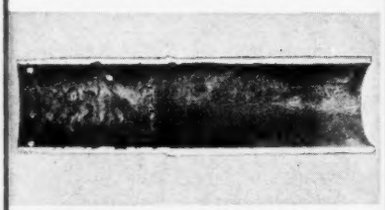
Welded Mills: ETNA, PENNA. SHARPSBURG, PENNA. *Seamless Mills:* AMBRIDGE, PENNA.

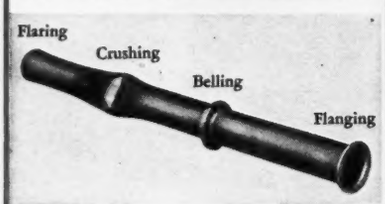
STANDARD
Seamless Steel
POWER PIPING

CAN ANY OTHER PIPE OFFER YOU AS MUCH?

Fe + Cu + Mo
Iron Copper Molybdenum

= TONCAN COPPER MO·LYB·DEN·UM





Thirty-two pages of interesting information for the benefit of pipe users who want up-to-the-minute data. *Just ask for your* copy of

"Pipe For Permanence"

AN ALLOY IRON

The result of more than twenty years of research,—Toncan Iron—a true alloy of pure iron, copper and molybdenum.

PIPE THAT RESISTS RUST

Not to the inclusion of foreign non-metallics does Toncan Iron owe its long life, but to a structure in which every tiny grain of alloy metal is, in itself, highly resistant to rust.

AND CORROSION

Under the most adverse conditions,—in corrosive soil, in wells producing sulphur laden oil, in oxygenated water lines, in steam lines, in condensers, in refineries, in coal mine service,—Toncan has proved its economy.

THREADS CLEAN AND FAST

The uniformity of Toncan Iron throughout its entire wall thickness insures positive ease of threading. No more effort is required than for threading any soft steel pipe.

AND WORKS EASILY

Since the structure of Toncan Iron is uniformly close grained and non-fibrous, this modern pipe can be bent, coiled, belled, flared, Vanstoned and otherwise worked with ease and satisfaction.

REG.U.S.PAT.OFF.
TONCAN
COPPER
MO·LYB·DEN·UM
IRON PIPE

As protection to you we mark it BLUE

REPUBLIC STEEL CORPORATION

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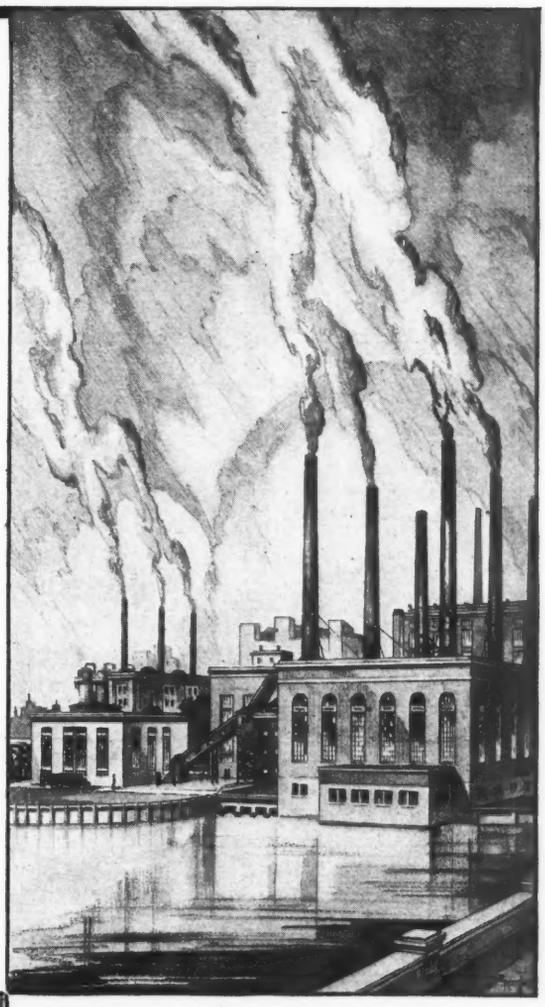
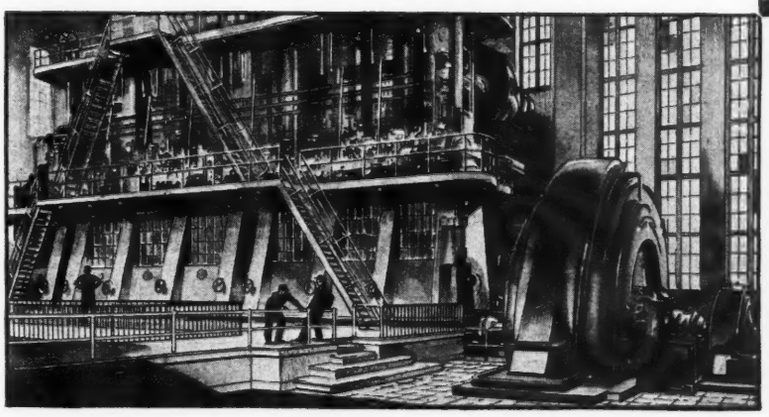
FINANCING
Single Units or Complete Plants



BUYERS OF POWER often foresee large savings through the installation and operation of their own power plants. Producers of Power often foresee similar savings through modernization. By using the Commercial Credit Plan both buyers and producers are effecting these savings without the aid of increased capital, bond issues or the impairment of operating funds.

Commercial Credit Plans are designed to allow payment for machinery and equipment of all kinds, from earnings. These plans have proved sound in practice. If yours is a replacement or expansion need there is a Commercial Credit Plan ready to serve you.

Write, today, for full information.



COMMERCIAL EQUIPMENT CORPORATION

Commercial Equipment Corporation, affiliation of Commercial Credit Companies, provides a further financing service to industry. Its method of financing complete installations as a unit, requiring two or more varying types and makes of equipment, has been approved and endorsed by many of the country's leading engineers.

COMMERCIAL CREDIT COMPANIES

COMMERCIAL BANKERS
CASH CAPITAL and SURPLUS $58,000,000

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COMMERCIAL CREDIT COMPANY, Inc., New Orleans
COMMERCIAL CREDIT COMPANY - San Francisco
KEMSLEY, MILLBOURN & CO., Ltd. - New York
AMERICAN CREDIT CORPORATION - - Omaha

MIDWEST COMMERCIAL CREDIT COMPANY, Detroit, Des Moines, Milwaukee, Sioux Falls - CONTINENTAL GUARANTY CORP. *of* CANADA, Ltd., Montreal

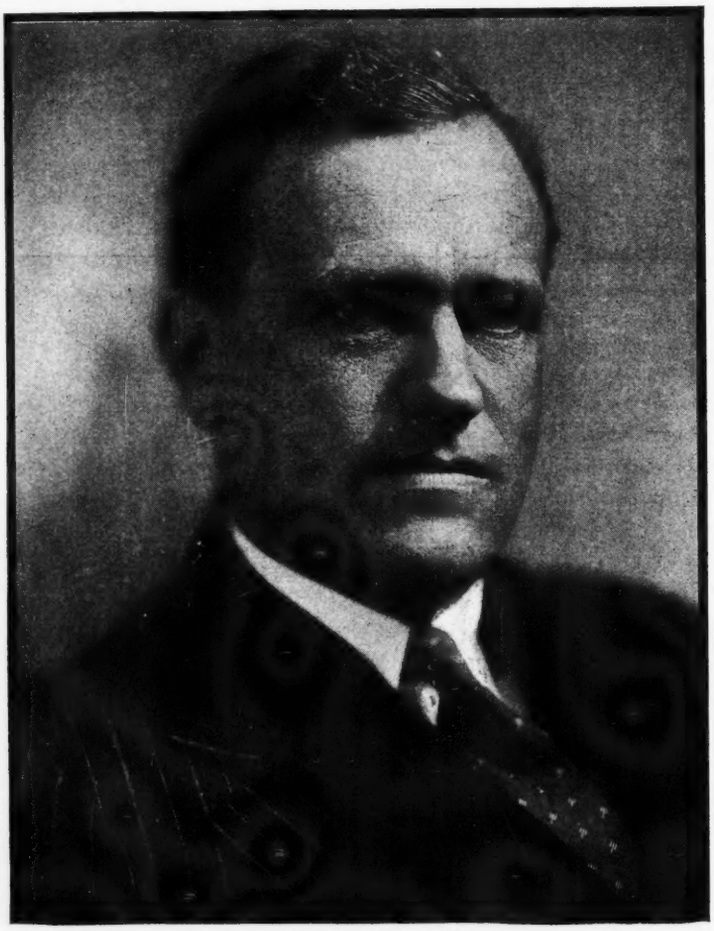
NATIONAL HEADQUARTERS, Baltimore

COMMERCIAL CREDIT COMPANIES, Baltimore, Maryland
Give us full information, without obligation, about Commercial Credit Plans.

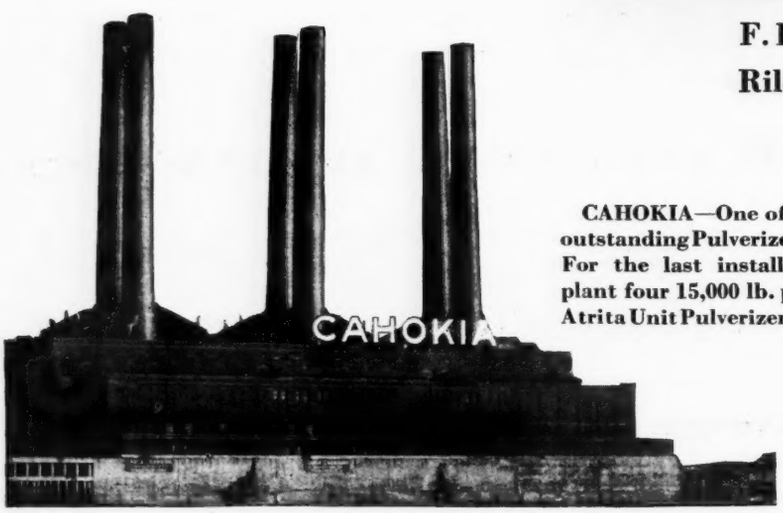
Firm Name ..... *By* .....

Address ..... *Title* .....

a Prophecy to which



F. H. Daniels . . . *President*
Riley Stoker Corporation



CAHOKIA—One of the country's outstanding Pulverized Coal Plants. For the last installation of this plant four 15,000 lb. per hour Riley Atrita Unit Pulverizers were selected

WILL YOUR FUEL BURNING EQUIPMENT

you are justly entitled

LOOKING AHEAD FIVE YEARS

Tremendous advances have been made in unit pulverizer design and operation in the past five years. Five years ago a unit pulverizer installation aroused genuine interest. Today to install unit pulverizers is merely a matter-of-fact incident.

The trend is definitely in favor of unit pulverizers for the reason that efficiency, economy and dependability are today's "business vogue."

Engineers are generally and rapidly accepting this method of firing as the most efficient. Each month the swing to unit pulverizers gathers momentum. After carefully considering all the factors, we feel safe in predicting that within five years from now, unit pulverizers will have outdistanced all other means of burning bituminous coal under boilers of over 500 rated boiler horsepower.

F. H. Daniels

President

RILEY STOKER CORPORATION
WORCESTER, MASS., U. S. A.

BOSTON NEW YORK PHILADELPHIA PITTSBURGH BUFFALO CLEVELAND DETROIT TACOMA ST LOUIS
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Riley Engineering and Supply Co., Ltd., Toronto — Riley Stoker Co., Ltd., London — American Trading Co., Japan
International Machinery Co., (W. R. Grace Co.) South America — Deutsche Evaporator Aktiengesellschaft, Germany
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Engineers have learned TRADE MARK Rx REGISTERED *to "Rely on Riley"*

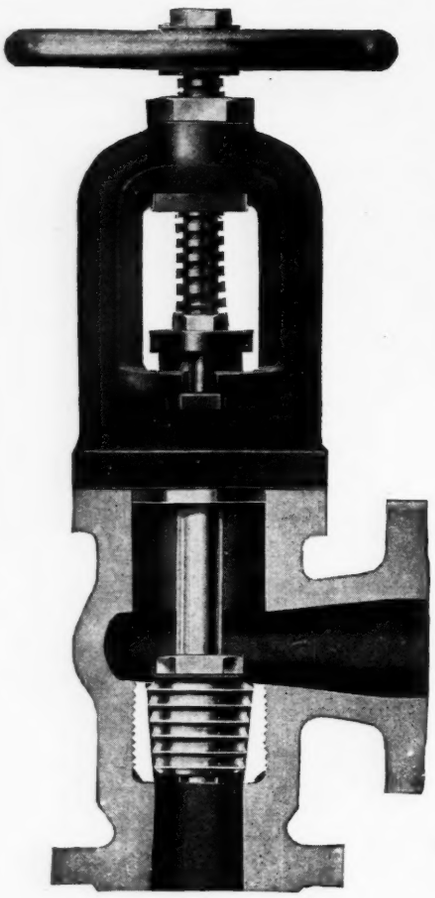
BE OBSOLETE WITHIN THE NEXT 5 YEARS?

No Scale Can Clog This Valve

Neither scale nor grit can impair the lasting tightness of the

LEE MULTI-STAGE VALVE

PATENTED



Lee Multi-Stage Valves are furnished angle and straightway in sizes from ¾ to 3 in. inclusive. Cast iron bodies are guaranteed to 200 lb. Cast steel bodies are guaranteed to 600 lb.

Special designs for higher working pressures can be furnished.

The grooves in the cone act as expansion chambers to reduce the pressure in steps as the cone approaches the seat, and thereby make scoring impossible. They also serve to water seal the valve by condensation of the steam and retention of the water entrapped within them in the closed position.

The Stainless Steel Cone

Note the deep corrugations machined to a scientifically determined contour, alternating with bead edged contact lands. The beads cut and crush the hardest scale as they meet the converging valve seat. The crushed scale serves as a lapping material for the lands when they burnish their seatings bright and tight with every opening and closing.

THE Lee Multi-Stage Valve insures maximum tightness in any service with practically no maintenance expense.

Both the stem and the loosely fitted cone are made of stainless steel. The end thrust of the stem inside the cone is taken by a bronze shoe and the cone seats against a renewable bronze seat. The use of these two hard metals for the bearing contacts prevents binding and insures long life.

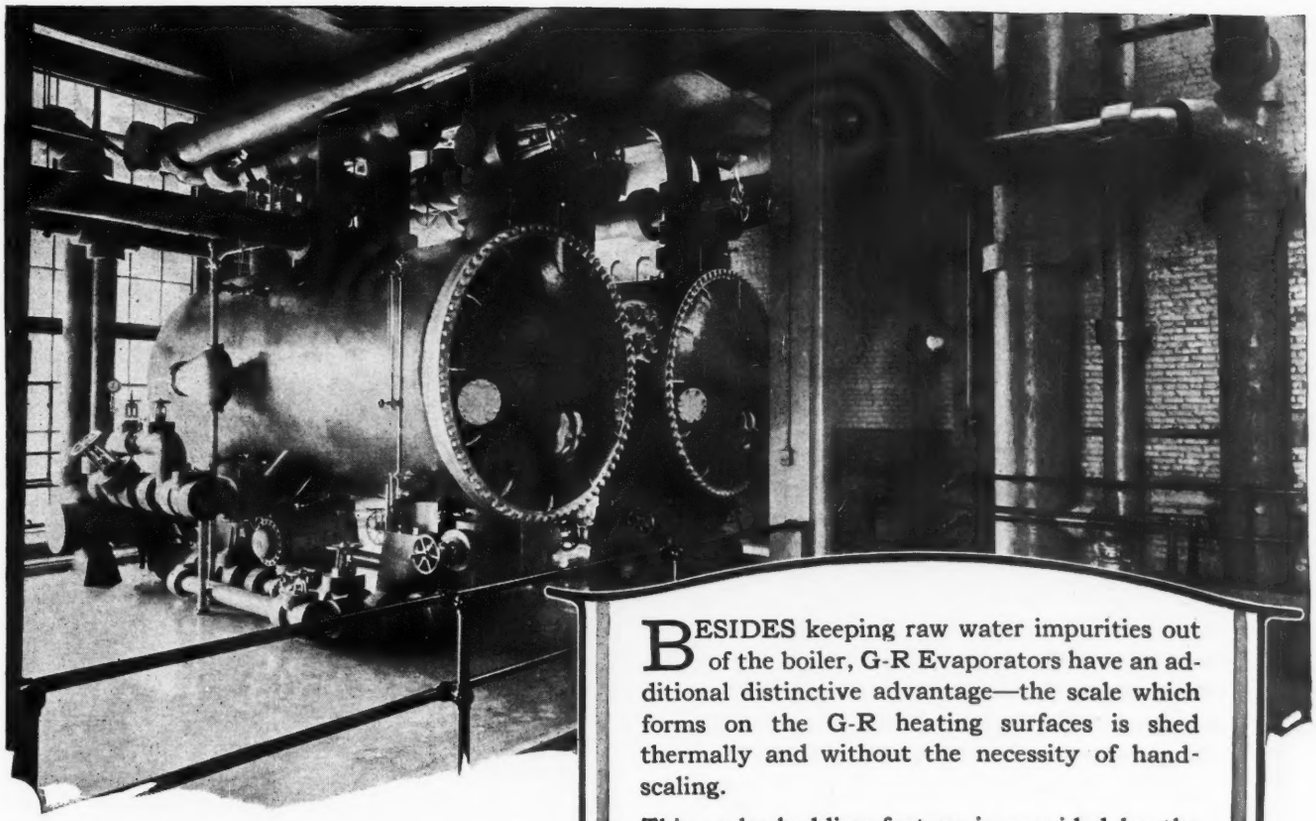
The Lee Multi-Stage Valve is adapted to steam boiler blow-off, water, air, oil, and other services that call for heavy duty throttling and tightness.

Write for Bulletin 100, containing full details and specifications.

MULTI-VALVE CO.

Multi-Valve Corporation

New London, Connecticut



The turn of a valve *cracks off the toughest scale from G-R Evaporator Tubes*

BESIDES keeping raw water impurities out of the boiler, G-R Evaporators have an additional distinctive advantage—the scale which forms on the G-R heating surfaces is shed thermally and without the necessity of hand-scaling.

This scale-shedding feature is provided by the special patented construction of the tubes or coils in G-R Evaporators. Changes in temperature cause varying distortion of the heating surface which cracks up and breaks off scale accumulation. Even the most tenacious scale is readily removed by blowing down the evaporator, filling with cold water and then opening the steam supply so as to heat the tubes or coils suddenly, with corresponding quick distortion.

The benefits of distilled boiler feed make-up and the many special advantages of G-R Evaporators are fully described in a new bulletin which will be sent on request.

The Griscom-Russell Co., 285 Madison Ave., New York

Philadelphia	Chicago	St. Louis	San Francisco
Boston	Cleveland	New Orleans	Los Angeles
Buffalo	Massillon	Houston	Seattle
Rochester	Detroit	Dallas	Portland
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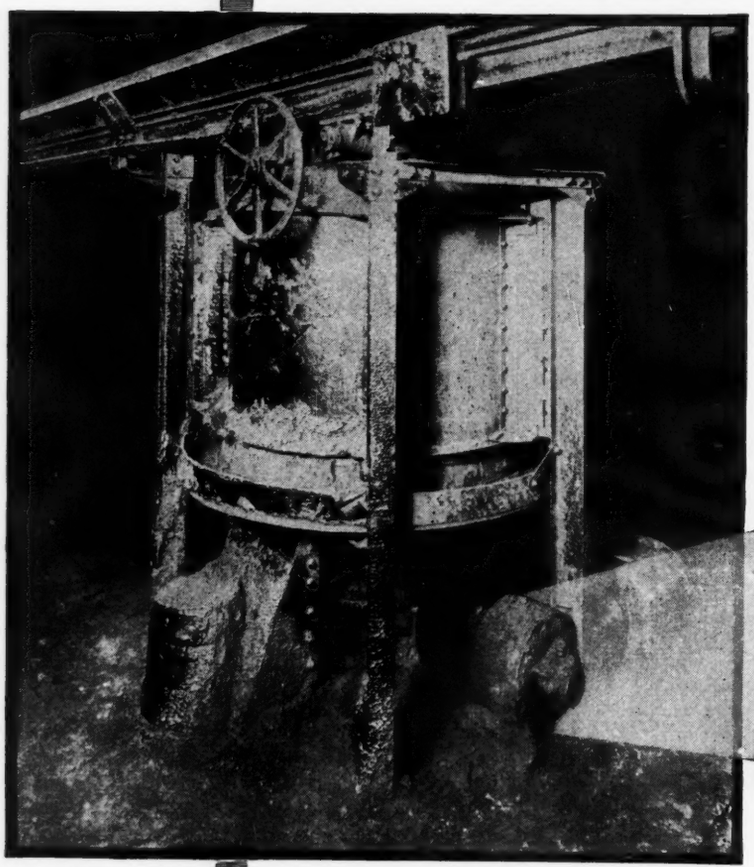
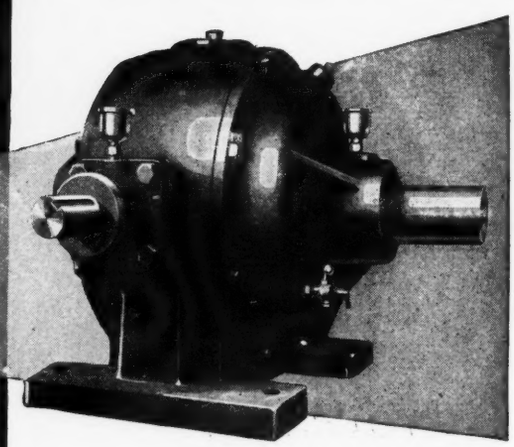
For Canada: Riley Engineering & Supply Company, Ltd., Toronto

Griscom-Russell

Heat Transfer Apparatus

DON'T HESITATE on Drive Problems like THIS - - - - -





G & F Products

Drop, Flat Hammer and Upset Forgings, Cut Gears
Speed Reducers
Rolling Mill Machinery
Special Machinery
Bridge Operating Mechanisms

These Catalogues Will Help You

Our line includes proper ranges in Worm, Planetary and Herringbone Speed Reducers.

DON'T hesitate where power must be transmitted under unfavorable conditions. Dirt, moisture or corrosive chemicals . . . inseparable from many manufacturing processes . . . cannot affect G & F Speed Reducers.

They are completely enclosed, self-lubricating units, fully protected against external operating conditions. All gears run in an oil bath within the dirt-proof, moisture-proof case. Their operation is positive, reliable and economical under the most severe conditions.

Our complete line of Worm, Planetary and Herringbone Speed Reducers includes a size and type for every need. We will gladly assist you in selecting the proper unit for your particular job.

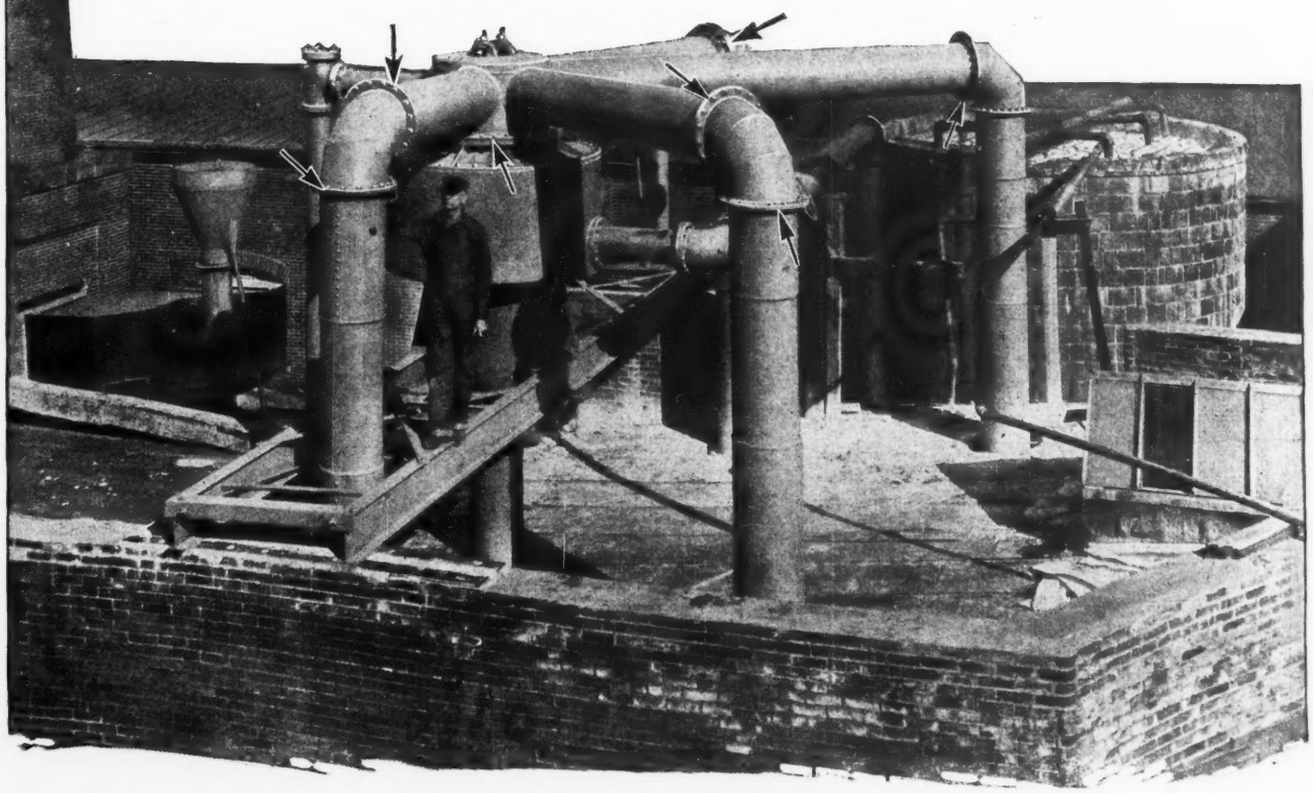
Don't hesitate on drive problems—send them to us for our recommendations.

GEARS AND FORGINGS, INC.

GENERAL OFFICES: 3144 WOODHILL ROAD, CLEVELAND, OHIO, U. S. A.
District Offices: Chicago - Pittsburgh - Detroit - Buffalo - New York - Milwaukee
Indianapolis. *Factories:* Cleveland - Pittsburgh - Chicago - Ford City, Pa.

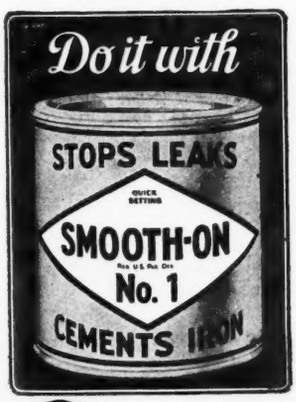
GEARS & FORGINGS INC.
SPEED REDUCERS

A Made thoroughly tight with SMOOTH-ON No. 1



IN THE plant of a large Texas cotton oil mill the vacuum system is built up with 18-in. welded pipe having welded steel flanges at the elbows. The flange faces were very rough and would not make joints that were tight at the gaskets.

About 25 lb. of SMOOTH-ON No. 1 were used to build up these faces to a smooth, correctly aligned surface, and the joints were then made with thin asbestos gaskets. The high vacuum that has been shown by the gauges ever since the system went into operation is proof that there is not a single leak anywhere.



Mail the coupon for your copy and get SMOOTH-ON *No. 1 in 1 or 5-lb. can or 25 or 100-lb. keg from your supply house or, if necessary from us.*

As a result of this satisfactory performance, the Engineer uses SMOOTH-ON No. 1 for similar pipe line work throughout this plant and says that he seldom has trouble from leakage.

Pitted, corroded or otherwise imperfect flange faces, when thoroughly cleaned and trued up with SMOOTH-ON No. 1 become as good as new for holding the gaskets and avoiding leakage.

You cannot appreciate what a service SMOOTH-ON No. 1 renders at bad joints or cracks until you have made the test or at least until you have read the SMOOTH-ON Handbook.

SMOOTH-ON MFG. CO.
Dept. 30, 570 Communipaw Ave., Jersey City, N. J.

Please send copy of the SMOOTH-ON HANDBOOK, 21st Edition.

Name .....

Address .....

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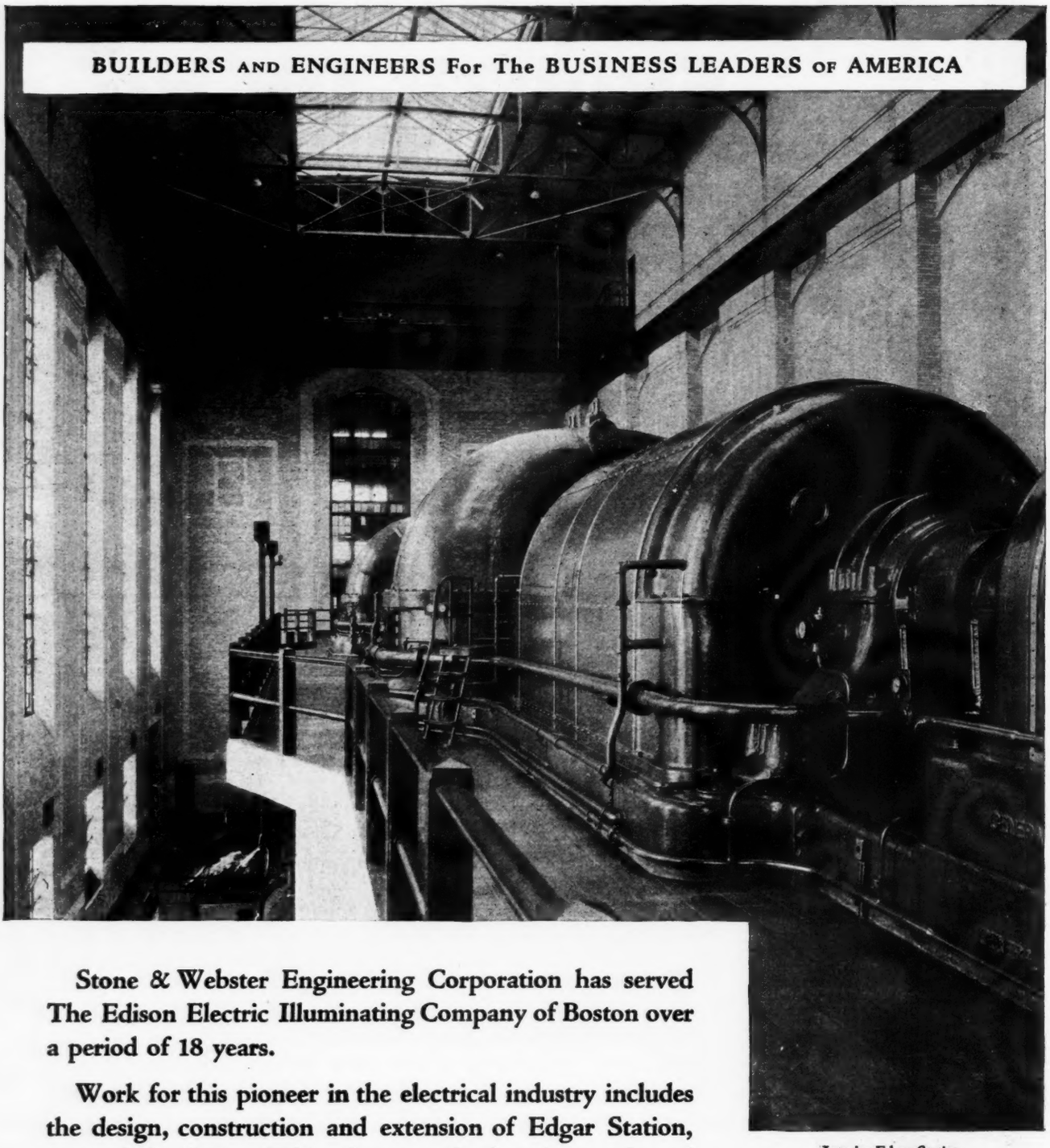
Do it with SMOOTH-ON

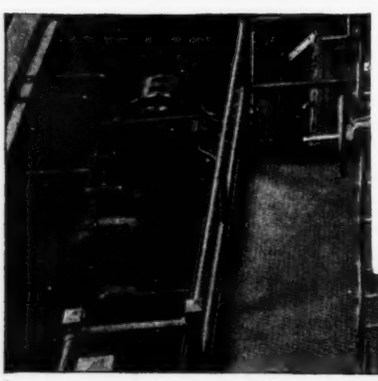
BUILDERS AND ENGINEERS For The BUSINESS LEADERS OF AMERICA



Stone & Webster Engineering Corporation has served The Edison Electric Illuminating Company of Boston over a period of 18 years.

Work for this pioneer in the electrical industry includes the design, construction and extension of Edgar Station, transmission line, switching house and substation work, and construction and alteration of service buildings.

Interior Edgar Station
The Edison Electric Illuminating Company of Boston
I. E. Moultrop, Chief Engineer



STONE & WEBSTER
ENGINEERING CORPORATION

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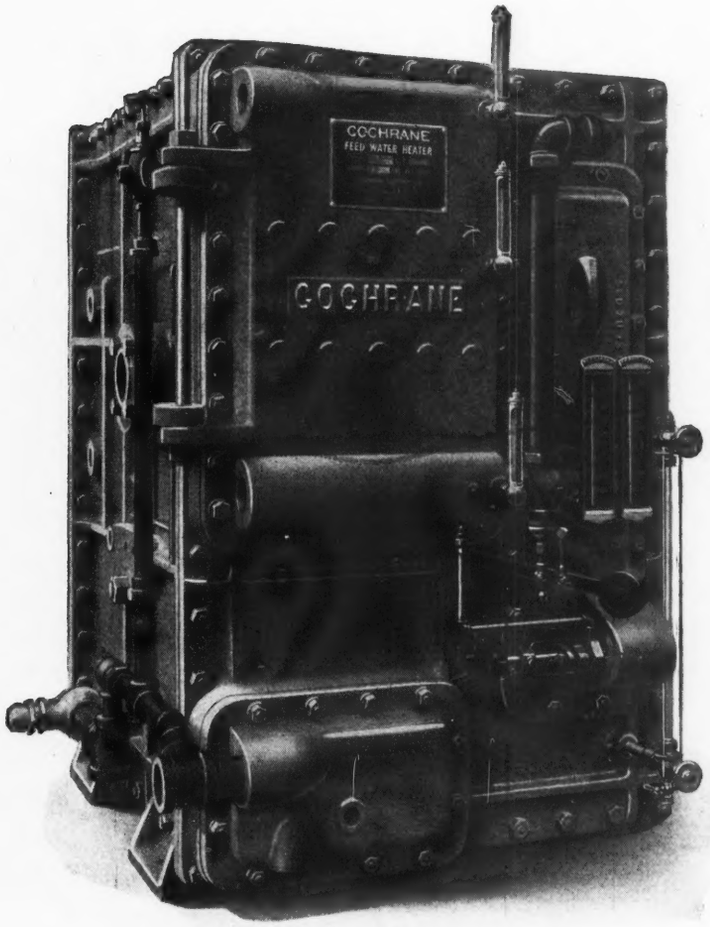


FOR THE PREVENTION OF CORROSION

in hot water service and heating systems, including piping, boilers, economizers, etc., and consequent red water troubles, the

COCHRANE DEAERATOR

will remove the dissolved oxygen which causes corrosion. Ordinary steel or iron pipe can then be used.

One form of Cochrane Deaerator, which is shown herewith, has been especially designed for installation in crowded engine and boiler rooms and low basements. There are no openings on the top, the bottom, the back and one side, and it can therefore be placed in a corner and up against the ceiling, providing maximum head on the suction of the circulating pump. All internal parts are easily accessible.

The admission of live or exhaust steam can be controlled automatically to deliver water at the desired temperature.

Our new Bulletin L-684 describes fully the equipment and piping layouts for buildings of various types.

COCHRANE CORPORATION

H-6

17th and Clearfield Streets, Philadelphia, Pa.

Smoke

Imagine yourself in a country peopled entirely by lunatics (yourself respectfully excepted). Idly you stroll along a country road, enjoying strange sights and sounds, until finally you come to a swimming hole where four men in bathing suits are disporting themselves in strange fashion. All four are actively stirring up the mud on the bottom with their feet.

Overcome with curiosity, you draw closer. Finally you engage in conversation one lunatic apparently more intelligent than his companions. "Why don't you gentlemen swim and enjoy yourselves," you ask. He turns on you a pair of reproachful blue eyes, clears his throat and replys: "Can't you see that the water is too muddy for swimming?" "But why don't you stop riling up the mud so the water will clear itself," you counter.

He turns indulgently. "Evidently, my dear man, you have not given this matter the philosophical attention it deserves. There are, you observe, four of us here, all intelligent men, although my analytical ability has made me the leader of the group. All of my actions are determined on a strictly rational basis."

"Now, to answer your question, I have already considered the remedy you propose and find it impracticable. My calculations show plainly that it would not pay me to forgo stirring up the mud. The water would still be muddied by my three companions and I should gain little or nothing for my trouble."

"Each of my companions has reasoned the matter out in similar fashion. We have, logically, decided to keep on as in the past since there is no practicable solution of the mud problem."

Thus the lunatics might reason.

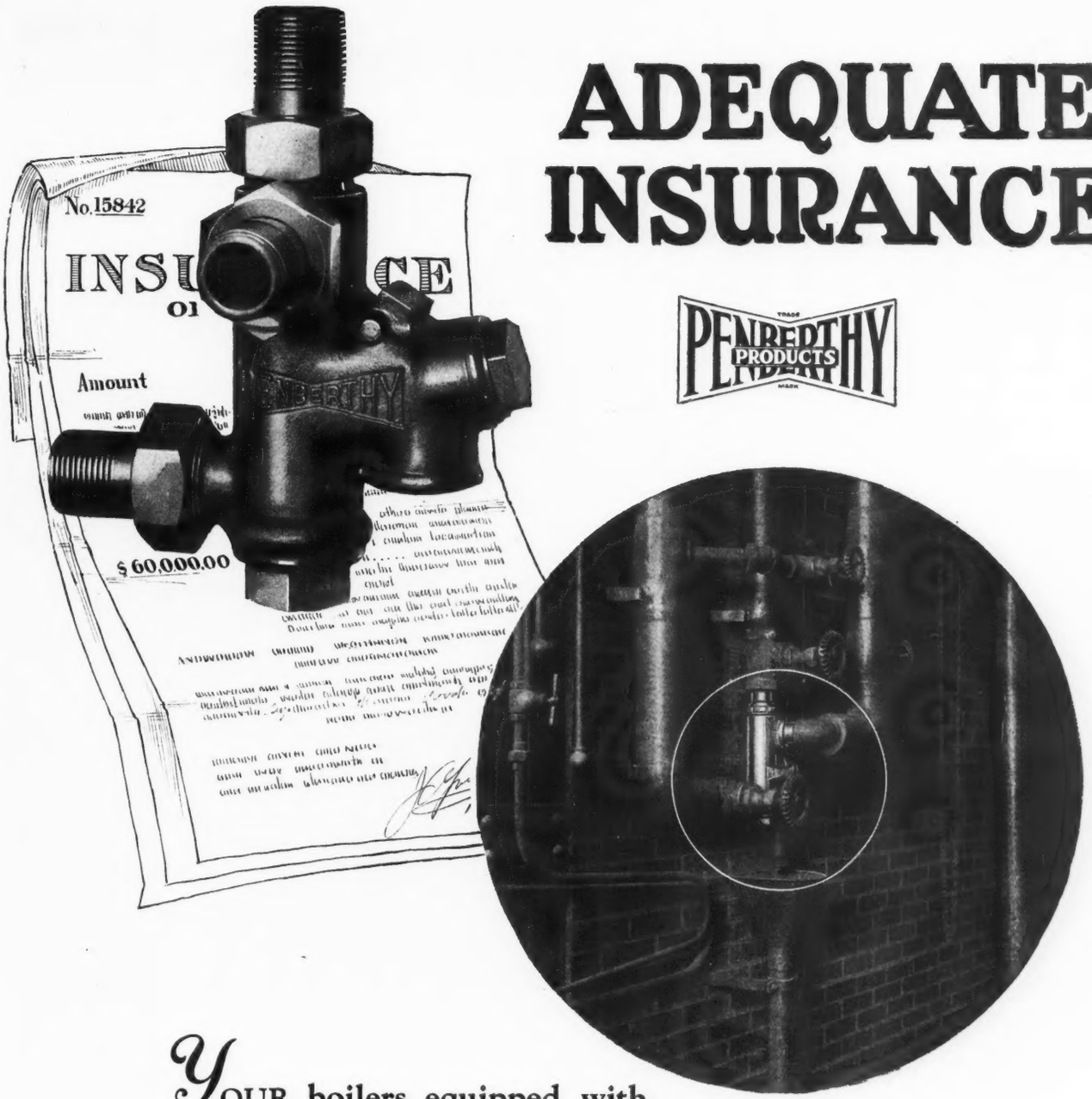
Now turn to a real community. Substitute air for water, the atmosphere for the swimming hole and smoke for the mud. To complete the picture, replace the lunatics by the coal consuming citizens of a typical smoky town.

Clearly it's the same old problem. All will admit that clean air in a smokeless community will save the group more than its total cost. Yet a single individual may not think it worth while to eliminate smoke if he cannot induce all other potential smoke producers to fall in line. As a result, little is accomplished.

The answer for sane men is to be found in organized co-operative effort. Unless smoke prevention is organized on a community basis, with intelligent rules and a man at the head with power to enforce them, progress will be slow. It is a community job in which the engineers must play a leading part.

George Edwards.
Engineer

ADEQUATE INSURANCE



PENBERTHY PRODUCTS

YOUR boilers equipped with Penberthy Automatic Injectors are absolutely safe from the danger of temporary failures in water supply.

The Penberthy Automatic Injector is always ready for instant action. It requires no attention and there is practically no maintenance cost—in short, it is the cheapest boiler feed insurance you can use.

There is a Penberthy Injector of the type and size to suit your individual conditions. Leading supply houses stock Penberthy Products for the power plant.

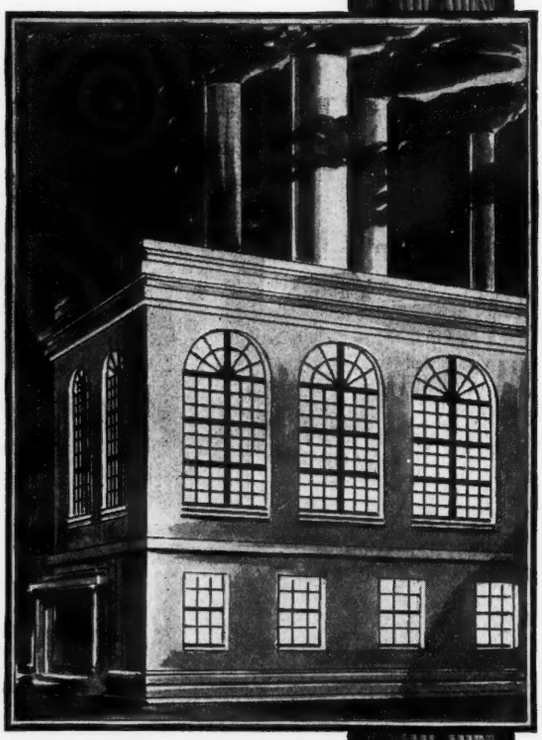
PENBERTHY INJECTOR COMPANY

ESTABLISHED IN 1886

DETROIT

CANADIAN PLANT WINDSOR, ONT.

IN POWER PLANT SERVICE WIRE ROPE QUALITY IS VITAL....



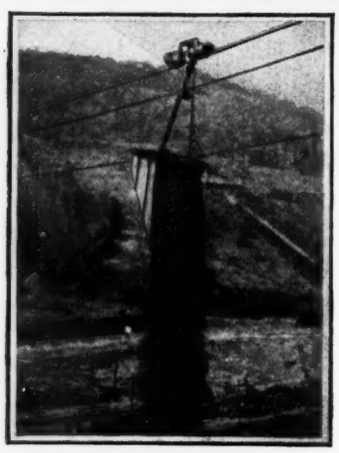
The use of Wire Rope for power plant purposes, is one of the important details on which perfect, uninterrupted service depends.

Therefore—your rope requisitions should call for a brand that has established, proved records under similar conditions.

American Wire Rope has back of it a half century of satisfactory and economical usage. Years and years of hard service, under every possible condition, have clearly demonstrated its superior quality and greater economy.

You can solve your wire rope problems by consulting with our nearest office. Our engineers will select the right rope for your needs.

AMERICAN TRENTON-BLEICHERT SYSTEM AERIAL TRAMWAYS



Our Reversible Refuse Disposal Tramways are one man operated and are equipped with patented four-wheel Tripping Carriages which dump the refuse automatically at any point without the use of tripping attachments on the cable.

« »

For waste disposal systems of long length American Aerial Tramways of the Trenton-Bleichert System are used.

AMERICAN STEEL & WIRE COMPANY

SUBSIDIARY UNITED STATES STEEL CORPORATION

208 S. La Salle Street, Chicago — 30 Church Street, New York

Other Sales Offices: Atlanta Baltimore Birmingham Boston Buffalo Cincinnati Cleveland Dallas Denver Detroit Kansas City Memphis Milwaukee Minneapolis-St. Paul Oklahoma City Philadelphia Pittsburgh Salt Lake City St. Louis Wilkes-Barre Worcester

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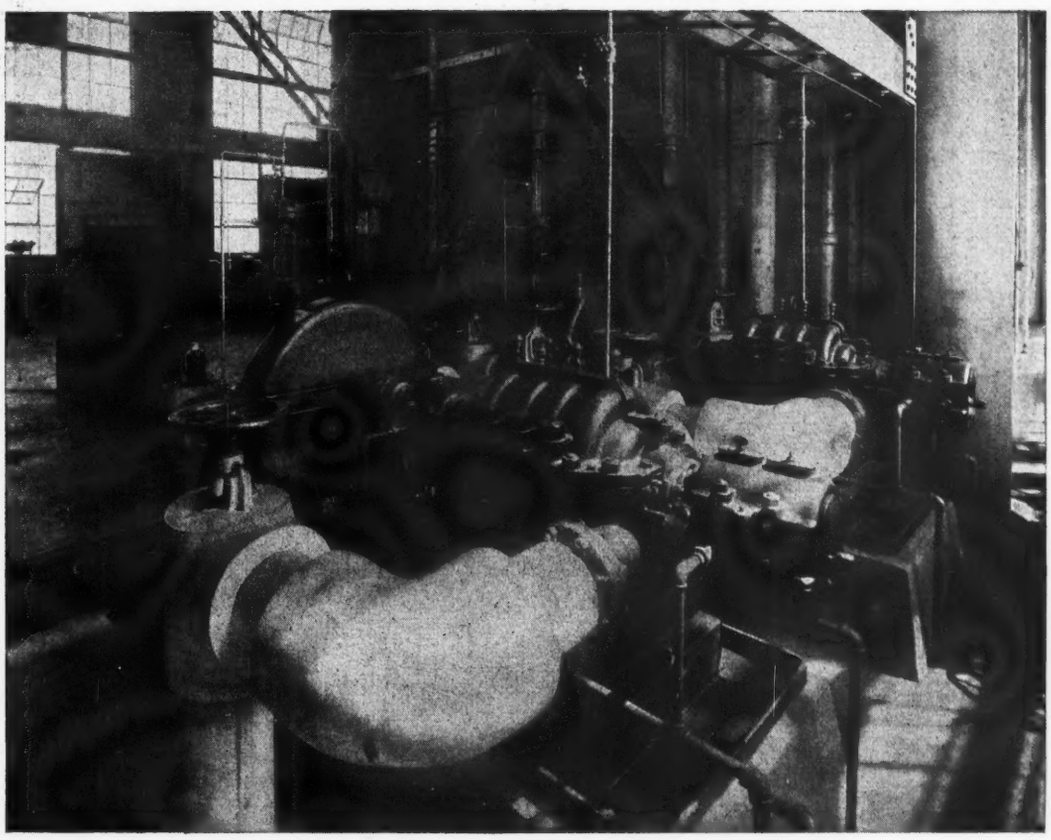
TERRY



MODERN TURBINES FOR A MODERN RAILWAY POWER PLANT

The Boston and Albany Railroad recently placed in operation at West Springfield, Massachusetts, a new and thoroughly modern boiler house. It replaces two old plants and supplies steam to the entire engine terminal.

All the essential auxiliaries at the new plant are operated by dependable Terry wheel turbines. These include two 45 HP boiler feed pump drives (illustrated above), two 87 HP geared fan turbines, and a 10 HP heater service pump unit.

The TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.
Steam Turbines - Gears - Shaft Couplings

T-1063

PENNSYLVANIA COMPRESSORS

CONTROL *Your* ELECTRIC POWER BILLS

PENNSYLVANIA *dual control* equipped, multiple belt driven air compressors, of type illustrated, effect a substantial economy in both power bills and floor space. Overhead method of motor mounting requires one-third less floor room than ordinarily occupied, while power saving by dual control in some cases exceeds 35%.

***Dual control* is ideally accommodated to plant conditions where full air capacity is not continuously required . . . under such conditions, the compressor automatically starts and stops to meet the actual air demands, but instantly, and while running, the control device may be switched to continuous operation.**

Request our representative in your district to give you full information.

PENNSYLVANIA PUMP & COMPRESSOR CO.

Main Office and Works: EASTON, PA.

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Atlanta	Chicago	Detroit	Milwaukee	Philadelphia
Albany	Cincinnati	Greensboro	Minneapolis	Pittsburgh
Birmingham	Cleveland	Greenville	New Haven	Rochester
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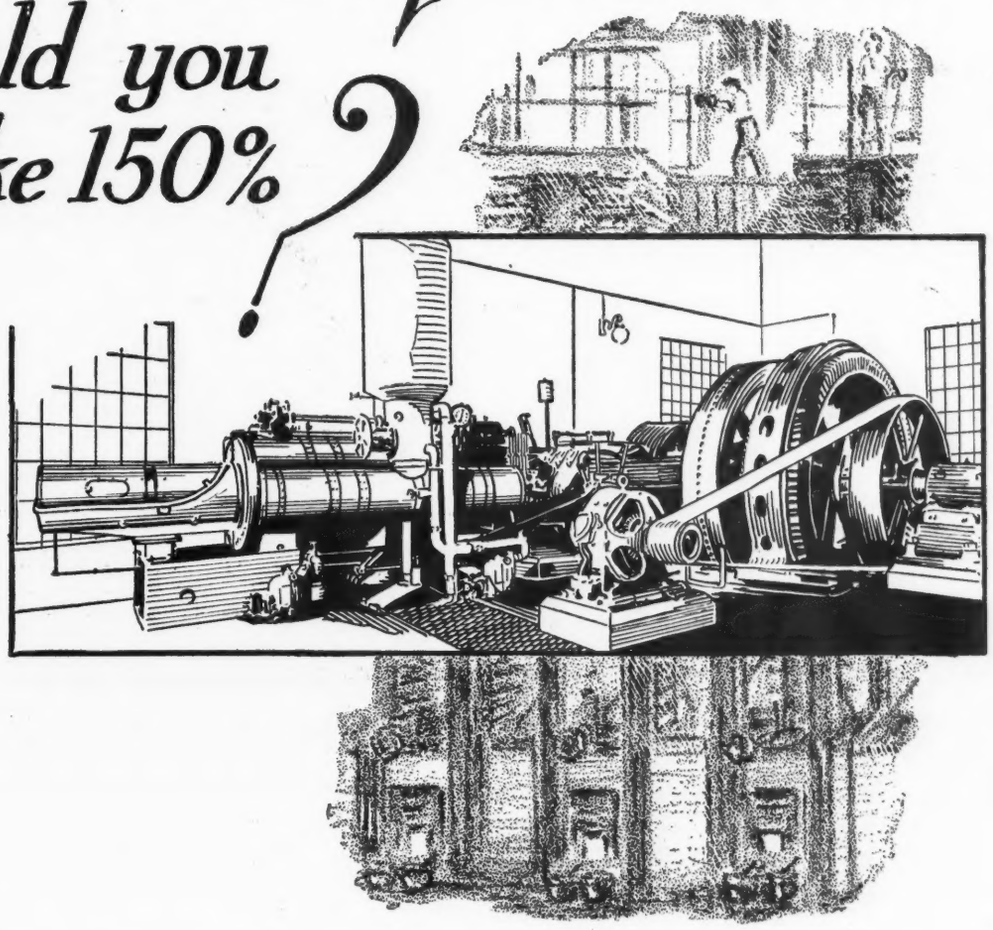
		Los Angeles		

Where else in your business could you make 150%?



FORTUNATELY for a large glass company, the decrepit condition of their old engines made them decide to shut them down and purchase current at the rate of 1.35 cents a kilowatt-hour.

We say, FORTUNATELY, because we enabled them to make 150% on their cash investment. We made a survey of their plant and agreed to furnish them a Universal Unaflow Engine with generator which cost $31,620 cars destination, and take $30,000 of the cost in savings made possible by the new engine, as compared with the cost of purchased current. We do not believe their total expense for erection and connection items including foundations, was over $10,000.00.

The equipment is paying for itself at the rate of $1250 a month or $15,000 a year. This is another of the many cases which have proved that Universal Unaflow Engines installed under the Skinner Guaranteed Saving Contract bring greater returns to the users than the same amount of cash invested in their own business. In fact, the purchaser is so well pleased with the operation of this unit that he has contracted for a duplicate unit under the Skinner Guaranteed Saving Contract, for another glass plant.

"The Most Economical Steam Engine Built"

THE "UNIVERSAL UNAFLOW"

BUILT ONLY BY SKINNER ENGINE CO., ERIE, PA.

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No human agency can prevent

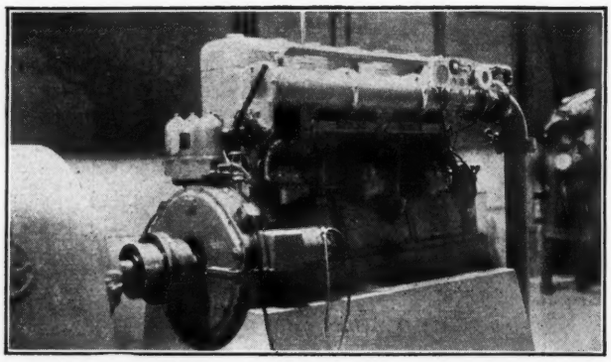
DROUGHT STORMS

Both interrupt power

And power is imperatively needed to afford light and water, essentials of modern civilization.

Sterling
High Duty
Internal
Combustion
Engines

12 to 565 B.H.P.
Gas or Gasoline



St. John River Power Co., at Grand Falls, N. B., employs a Viking 11-6 cyl., 425 HP., 1200 R.P.M., engine to drive a G.E. generator for standby service. H. G. Acres & Co., Ltd., Niagara Falls, Ont., consulting engineers.

Engines for any emergency.

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"BEST AT EVERY TURN"

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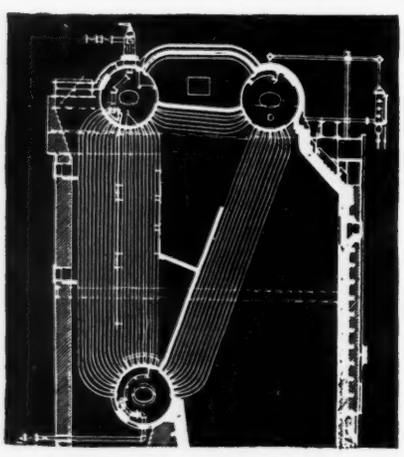

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THE CONNELLY THERMO-WATER STABILIZER
(Patents Pending)

THIS new Connelly design feature gives 100% water-heating surface, insures an exceptionally high efficiency, prevents burning and warping of tubes and makes for many other operating efficiencies. Built in units up to 15,000 square feet of heating surface and for pressures up to 600 lbs.

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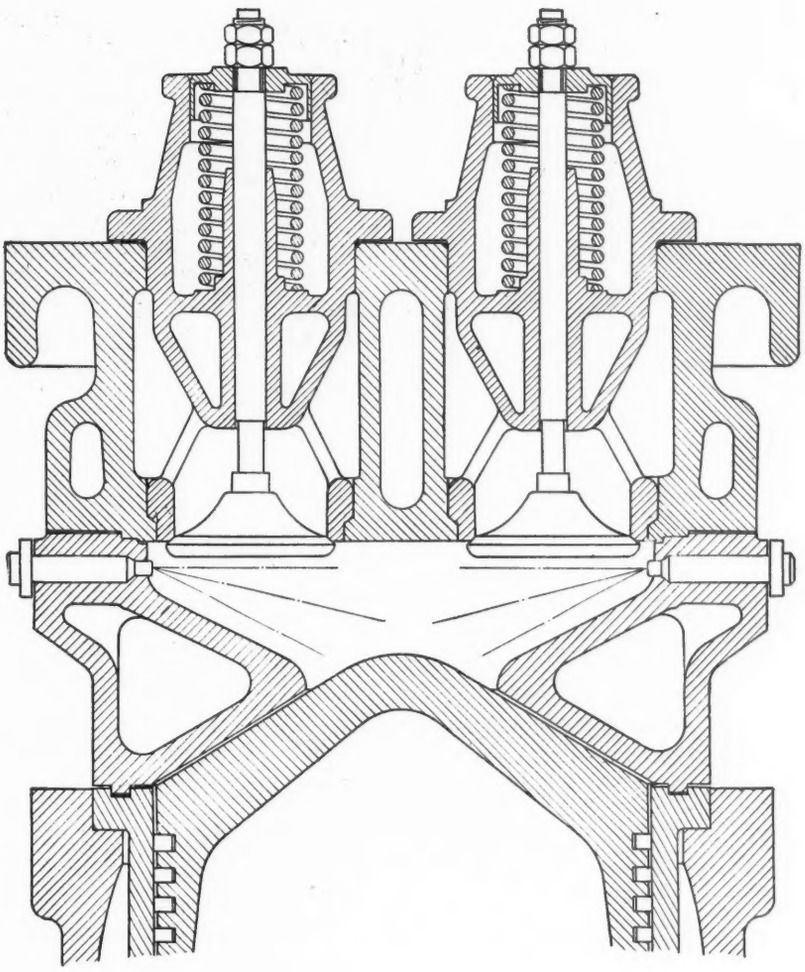
BOILER SPECIALISTS FOR 55 YEARS

DE LA VERGNE DIESELS

WITH

22" UNCOOLED PISTONS



Having started, in 1917, the worldwide trend toward Solid Injection Diesels, De La Vergne at the same time produced, in its efforts toward simplicity of design, an engine which has led to world renown—*and the only successful Diesel with a 22 in. uncooled piston.* The important reasons are absence of direct impingement of flame jets upon piston and the shielding action of the water cooled combustion chamber as can be seen in the accompanying view.

Economy, reliability and *simplicity* go hand in hand with successful operation.

You owe it to yourself to investigate De La Vergne.

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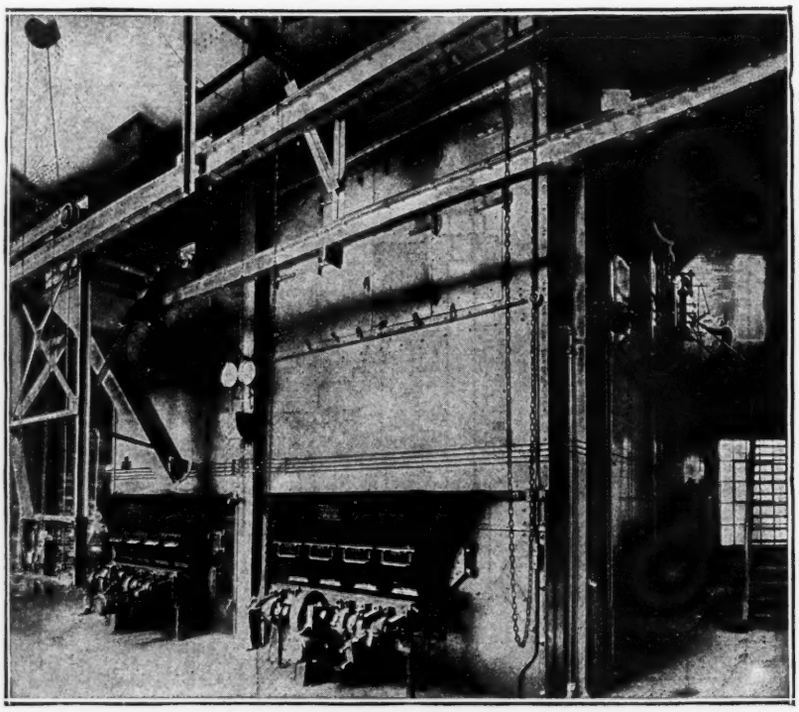
RICHMOND & NORRIS STREETS, PHILADELPHIA, PA., U. S. A.

WICKES CROSS DRUM BOILERS



A model laundry with a modern power plant. Unretouched photograph, 2—400 hp. Wickes Cross Drum Boilers. American Laundry Co. (Otte Bros.), Grand Rapids, Michigan. W. W. Bradfield, Consulting Engineer.

The factors of reliability, efficiency, and economy are equally desirable to all users of steam boilers. Competition today demands low unit production costs. In order to obtain this, all mechanical equipment must be highly efficient — combined with a low cost of maintenance and operation.

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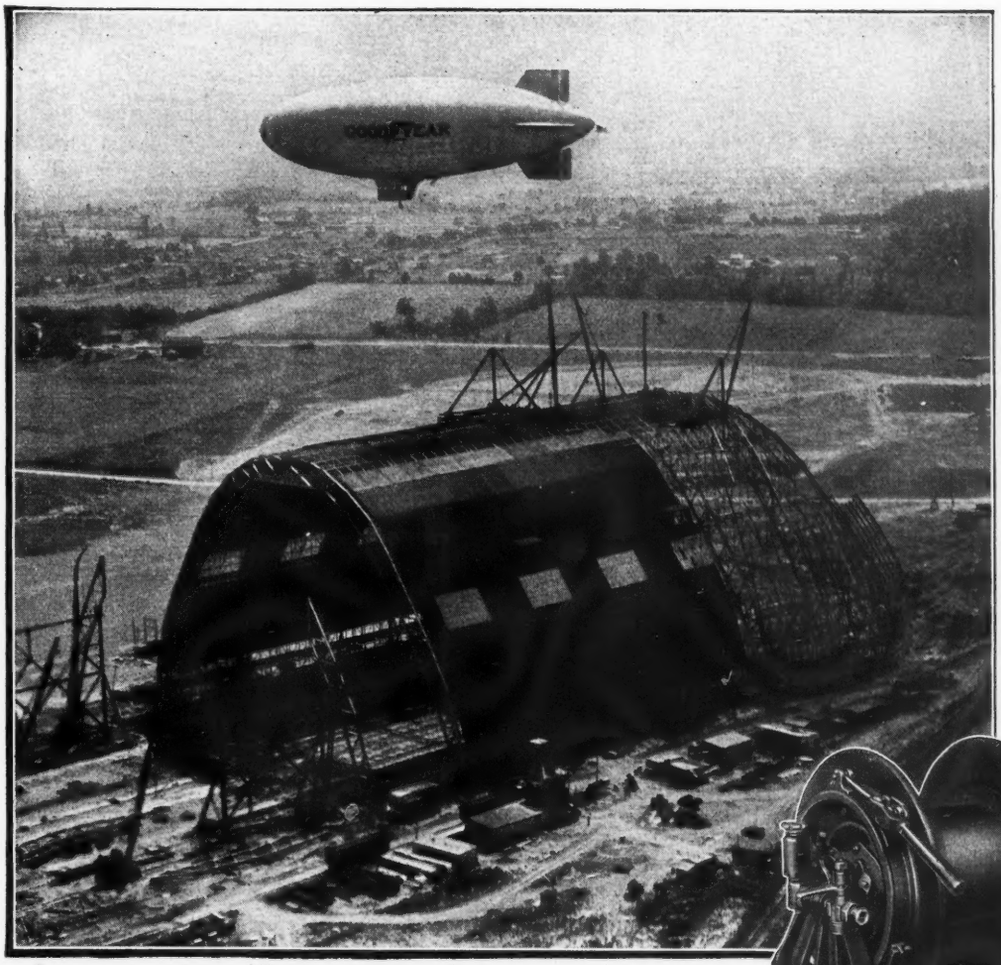
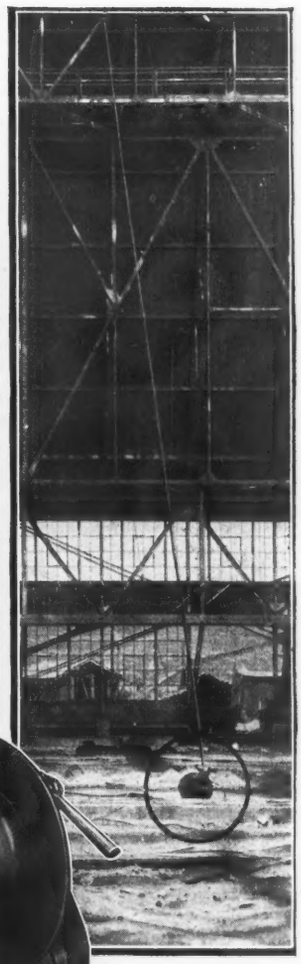
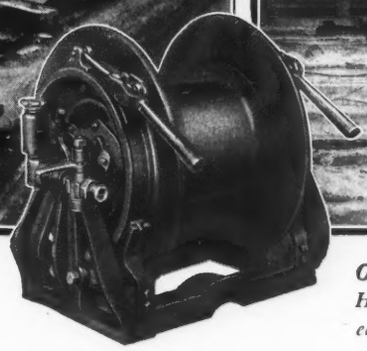


The New Goodyear Dock under construction





One of 12 Sullivan Hoists which erected the Sheathing.

Link in World Zeppelin Service finished on schedule

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Three miles southeast of Akron, Ohio, air power helped erect the largest airship dock in the world.

The floor is large enough for ten football fields. Yet it is dwarfed by the roof, which could shelter several Graf Zeppelins.

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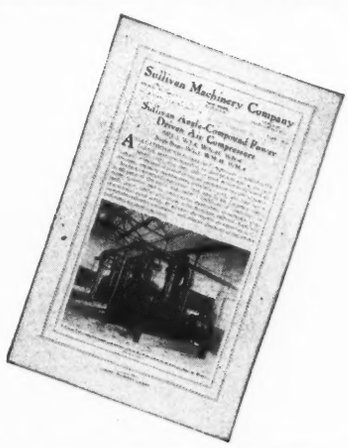
Twenty air and electric hoists are in the Sullivan line. One, two, and three-drum hoists, from 3 to 75 H.P. are available, for loading and unloading material, for spotting cars, for pulling scrapers, and for many other tasks in and around the plant. *Catalogs 75-F, 76-G, 76-J, describe them.*

Catalog 83-J describes Sullivan Balanced Angle Compressors which have been adopted by leaders in every industry.



For information on Sullivan Air Compressors for industry, send for Booklets 83-J, 83-I, 83-H.

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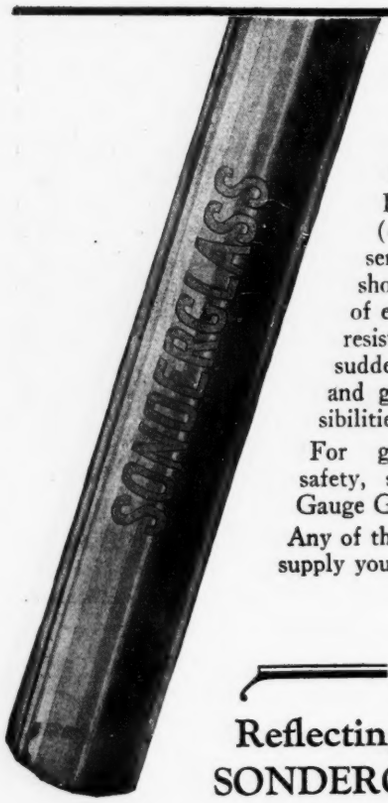
That Protects Your Eyes From Splintered Glass!



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Its special construction (complete fusion of two semi-metallic substances showing different degrees of expansion) gives greater resistance to the effects of sudden temperature changes and greatly reduces the possibilities of failure.

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Any of the agents listed here can supply you—or write direct.

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—a red stripe on a white background, magnified by the water, which gives a no-guess indication at a distance or in the shadows. Otherwise, the same as the regular style.

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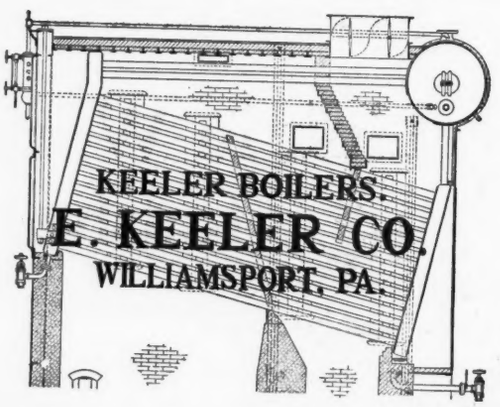

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SECTIONAL
ALL STEEL
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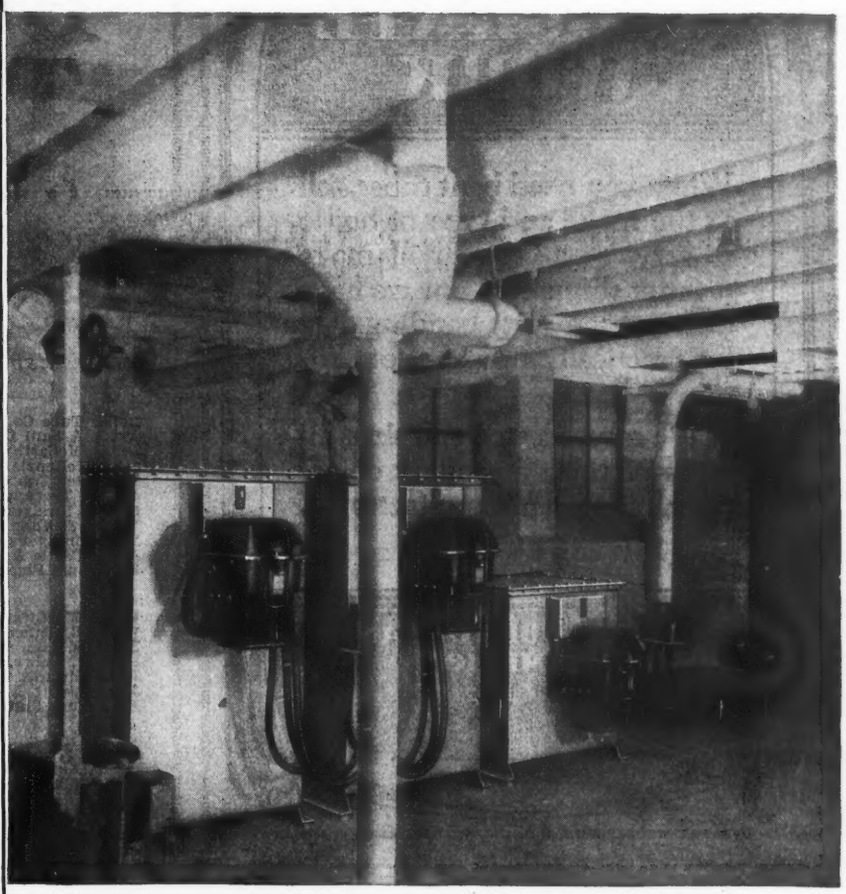
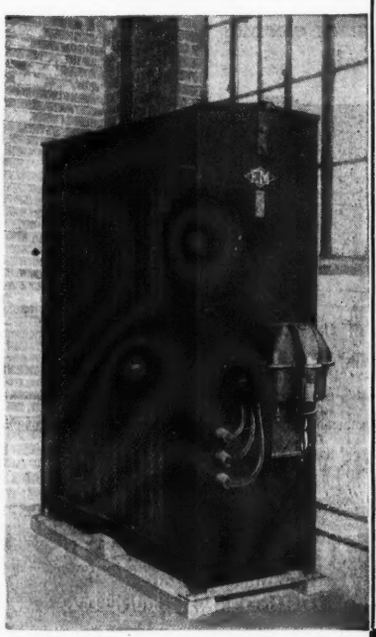
THIS SIMPLE INSTALLATION OF E-M CAPACITORS

SAVED $610.28 IN A SINGLE MONTH



Three of the six E-M Capacitors referred to below. Two are 120 kv.-a and the other is 60 kv.-a. Note the small space required.

Cell-type E-M Capacitor for indoor installation. Can be placed anywhere within the plant at small cost for installation.



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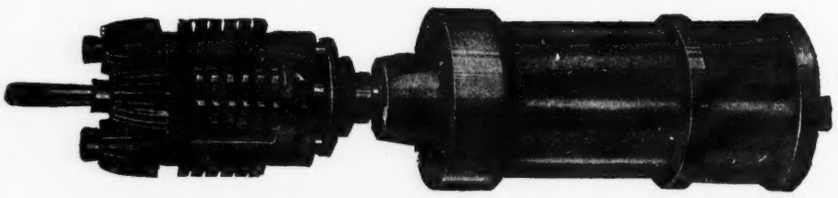
Four Cleanings a Year May Be Cheaper Than One

The average cleaning time per boiler is reduced by more frequent cleaning and more uniform efficiency of the boiler is maintained.



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Roto Cleaners can also be furnished for various sizes and types of tubes.

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protects
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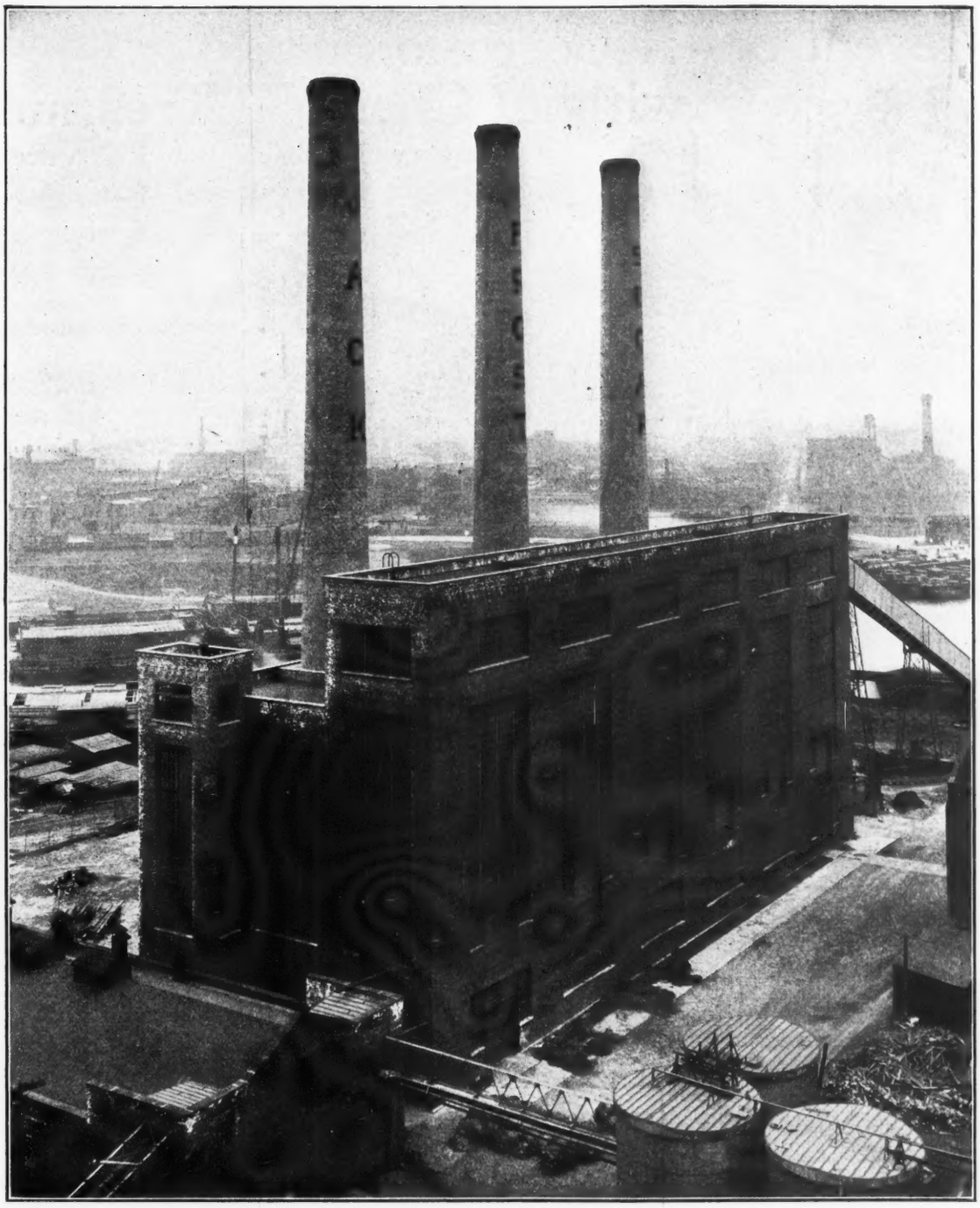

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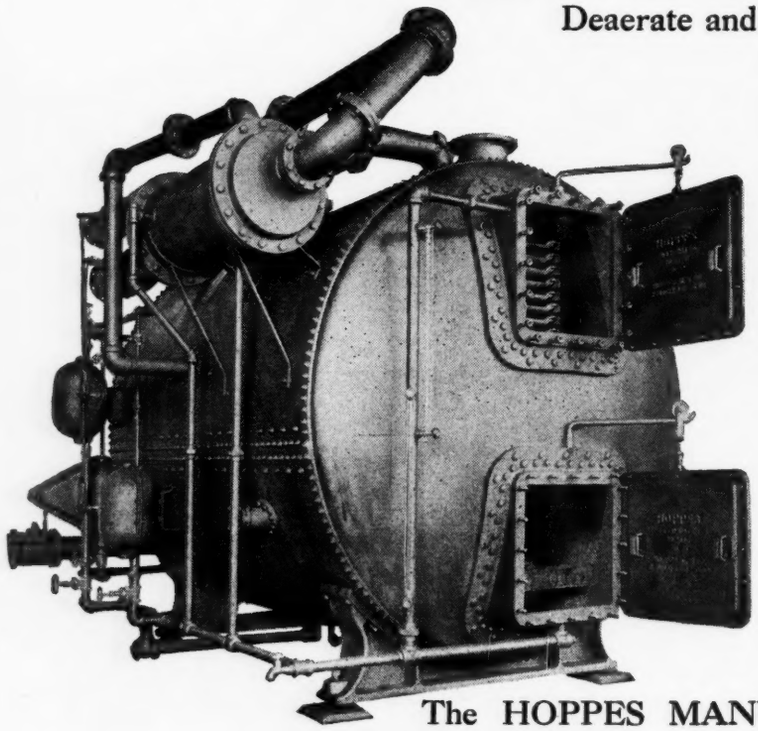
Prevent Boiler Corrosion without Chemical Treatment

Deaerate and purify the raw feed water make-up in



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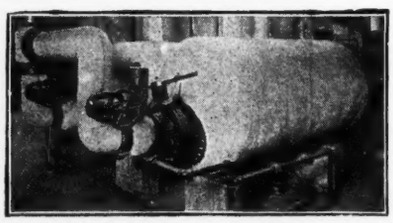

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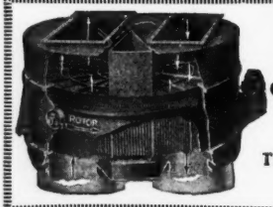

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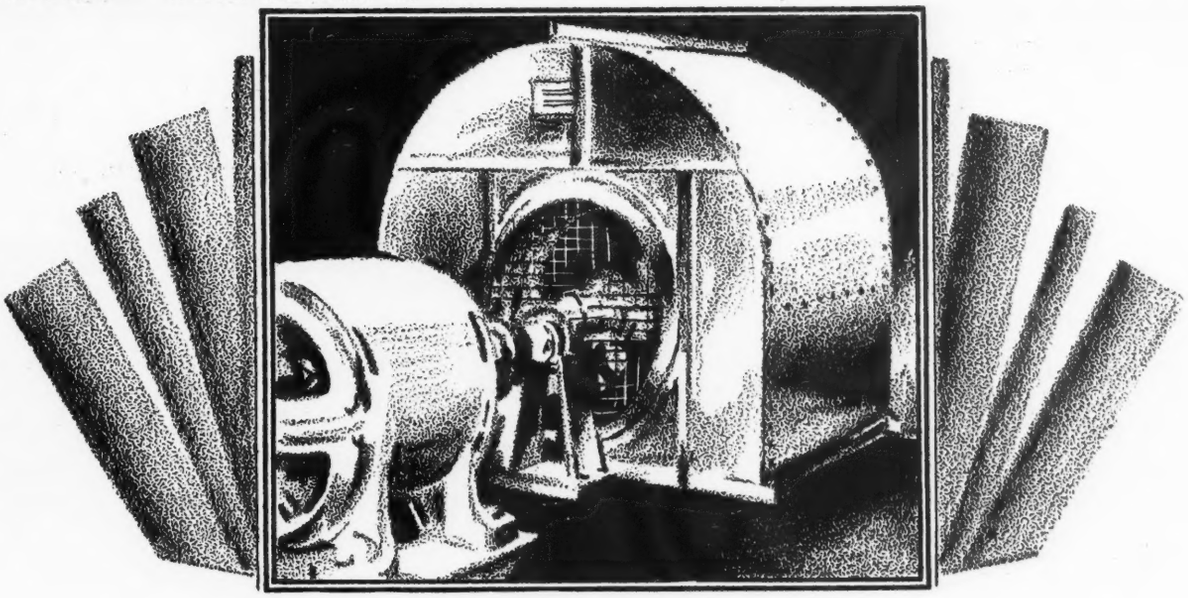

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why these blowers are preferred

MODERN power plant practice calls for the best in mechanical draft equipment. In the Clarage Type FD Blowers—these high speed units for direct motor or steam turbine drive—you find just that.

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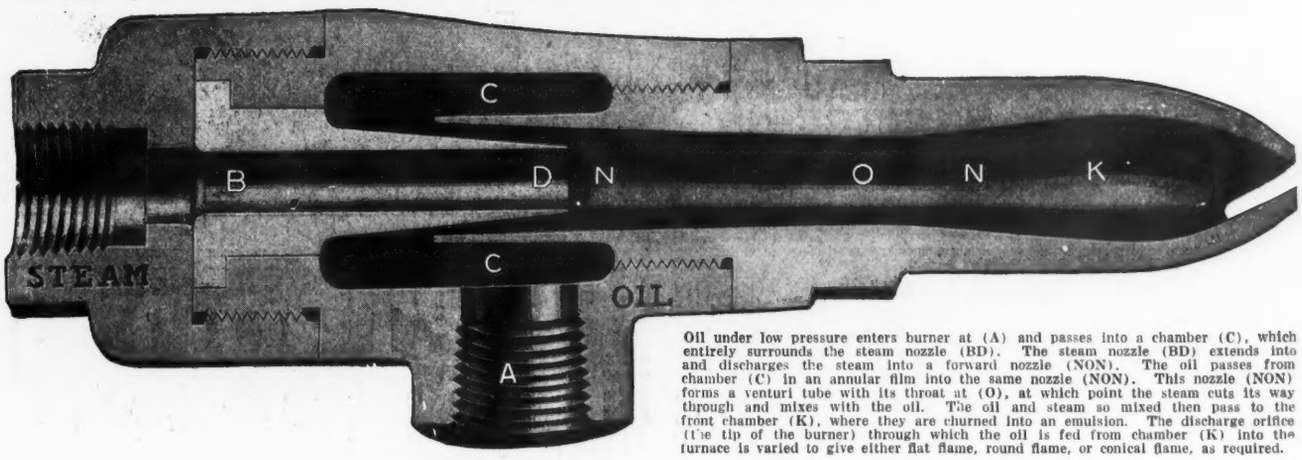
POWER!



Oil under low pressure enters burner at (A) and passes into a chamber (C), which entirely surrounds the steam nozzle (BD). The steam nozzle (BD) extends into and discharges the steam into a forward nozzle (NON). The oil passes from chamber (C) in an annular film into the same nozzle (NON). This nozzle (NON) forms a venturi tube with its throat at (O), at which point the steam cuts its way through and mixes with the oil. The oil and steam so mixed then pass to the front chamber (K), where they are churned into an emulsion. The discharge orifice (the tip of the burner) through which the oil is fed from chamber (K) into the furnace is varied to give either flat flame, round flame, or conical flame, as required.

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National Airoil Burners can burn the very lowest grades of liquid fuel completely and efficiently, using steam or compressed air for atomizing the oil.

National Airoil Burners will operate continuously without clogging and without need of cleaning and will consume every atom of the heaviest fuel. They will operate equally well at any point between its minimum and maximum capacity, and will hold with absolute precision any flame regulation required.

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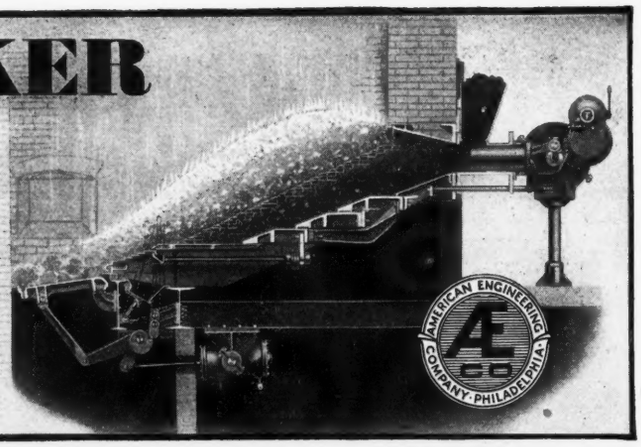

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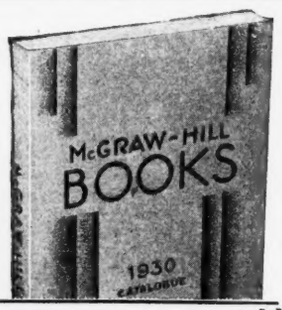

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Enco Burners for oil or gas will lower the cost of steam when burning any of these fuels.

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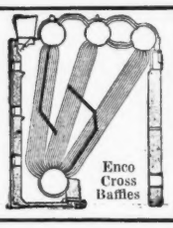
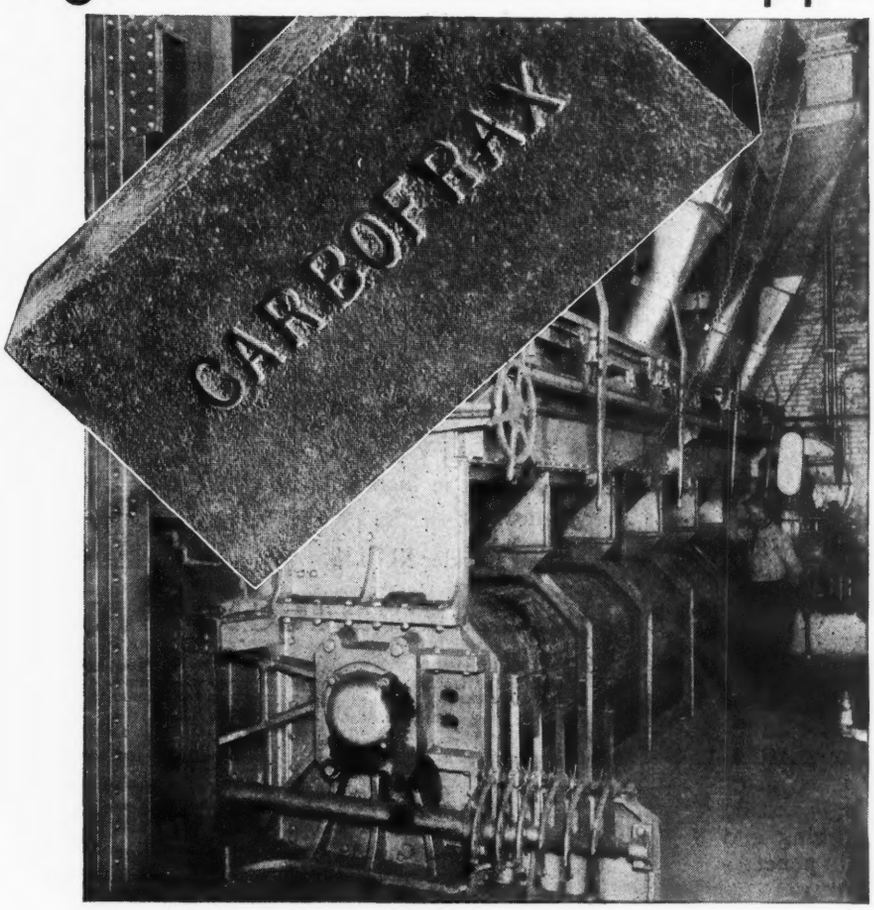

Enco Cross Baffles

Enco S.A.R. Burner Unit

Again an instance of an appreciable saving



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69.5%

USING CARBOFRAX
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The Carborundum Brand Silicon Carbide Brick
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THE Atlantic City Electric Company is actually saving $1,071.15 per boiler per year by using "Carbofrax" Brick.

Not only does "Carbofrax" show much longer life than ordinary fire clay brick—average of two years against eight months—but the clinker evil has been eliminated—labor costs greatly reduced—and shutdowns for lining repairs are now far less frequent.

The complete story of the achievement of "Carbofrax" in this plant with all facts and figures gladly sent on request.

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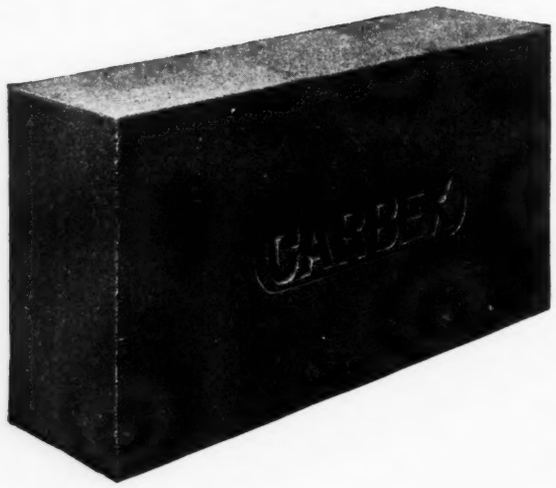
For high-temperature boiler furnace linings



CARBEX—a silicon-carbide refractory of the highest type—is ideal for high temperature boiler and industrial furnace linings.

In CARBEX only the purest silicon-carbide crystals are used, bonded and protected for maximum resistance to all destructive influences. Due to our process of manufacture, CARBEX Bricks and Blocks neither grow nor disintegrate in service. Their high melting point protects against fusion with slag and their smooth, dense surface prevents penetration and minimizes adhesion of clinkers.

The great strength of CARBEX assures safe support for heavy upper furnace walls, and its high refractory properties enable it to withstand internal and surface disintegration and all other destructive influences of hard physical punishment and high furnace heat at temperatures well above 3300 deg. Fahr.

If your furnace lining maintenance costs are now excessive, CARBEX offers the opportunity to make astonishing annual material and labor savings.

Write for FREE Booklet

—tells exactly what you should know about refractories under all boiler conditions and describes our complete lines of CARBEX and STEEL MIXTURE Bricks and Blocks for use at all furnace locations.

STEEL MIXTURE Products, made of the famous refractory used in over 16,000 installations, include Boiler Door Arches, Fire Box Lining Blocks, Air Cooled Furnace Walls, Back Combustion Chamber Arches, Blow-off Pipe Protectors, Fire Brick, Tile, High Temperature Cements and Repair Daub.

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CUT DOWN YOUR REPAIR COSTS

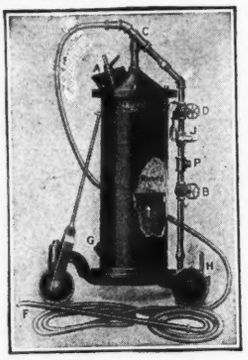
The price of materials is only one of the factors in maintenance costs. The loss due to shut-downs for repairs is an even greater and more serious cost.

Repairs to Walls and Arches of furnaces can be done quickly, even while the furnace is hot, with the QUIGLEY REFRACTORY GUN.

Refractory mixtures of HYTEMPITE and Crushed Fire Brick are shot directly to the spot where repair is needed, and become a part of the structure.

The QUIGLEY GUN pays for itself in increased production.

Write for Booklet RG 138.



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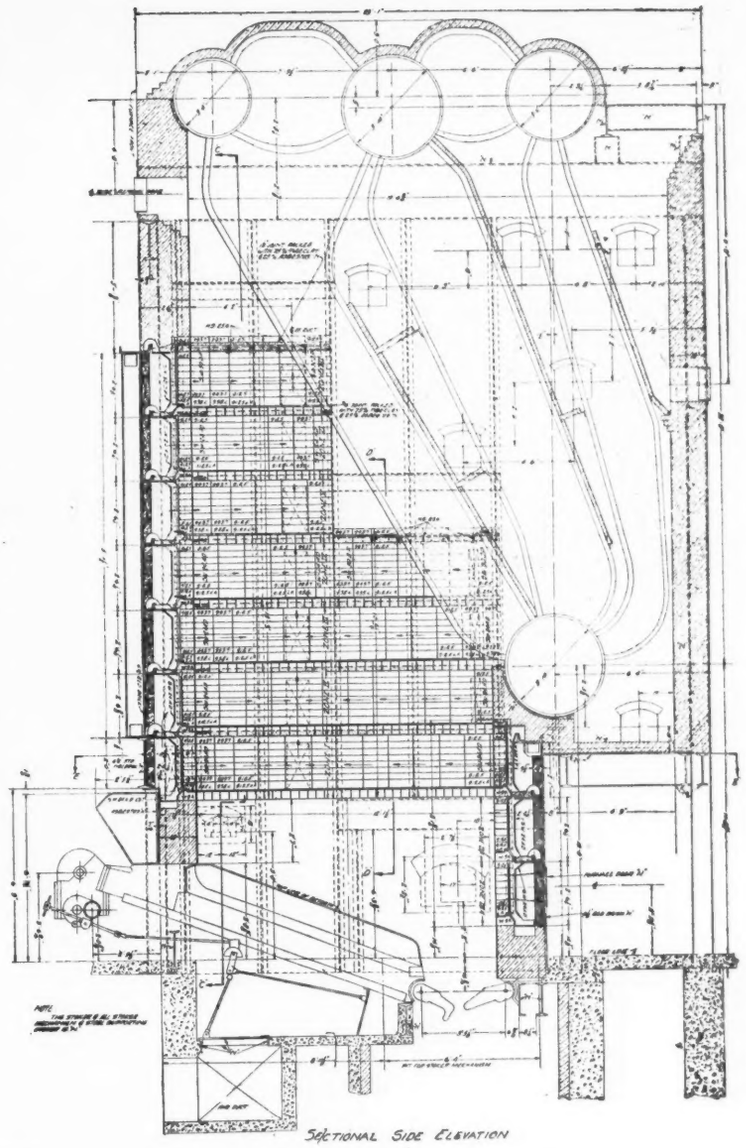
Fifteen companies above account for seventy separate Detrick installations—arches, walls or both—and over 150 settings. Illustration shows the *fourth repeat* for Graham-Paige.



Automotive Leaders *Keep Coming Back to Detrick*

Well over fifty manufacturers of automobiles and automotive supplies *in addition* to the list above are satisfied Detrick customers. Ford Motor, with two dozen separate jobs in a half dozen plants—Lincoln and Fordson adding still others—Fisher Body, with ten jobs in three different plants, and Studebaker, a seven-time repeater, only head-line a story of repeat orders that continues with Firestone, Timken, Willard and many other famous names.

Twenty rubber companies, a half-dozen each of wheel and body concerns and several makers of famous trucks appear in the Detrick list. And beyond all these another growing list of airplane and air accessory plants shows how fast this newer industry has copied a Detrick lesson from the older one.

No industry has ever bent itself to securing manufacturing efficiency with greater determination and success than the automotive. That an industry so minded, so wholly unhampered by tradition, should come so close to standardizing on Detrick is evidence enough that Detrick design and dollar-efficiency go hand-in-hand.

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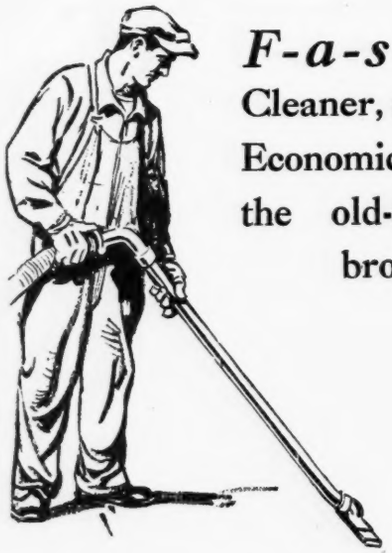
"Better than the Refractory of which They are Made"



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TABCO Industrial Pneumatic Systems

collect *every sort* of dust in *all sorts* of Power Plants.

Because TABCO Engineers are specialists in the field of heavy duty vacuum cleaning, you may be sure that their solution for the economical cleaning of your plant will be satisfactory to you not only at first, but over a period of years. The operating cost is low. No upkeep expense. Using TABCO, a few men can do the work of many.

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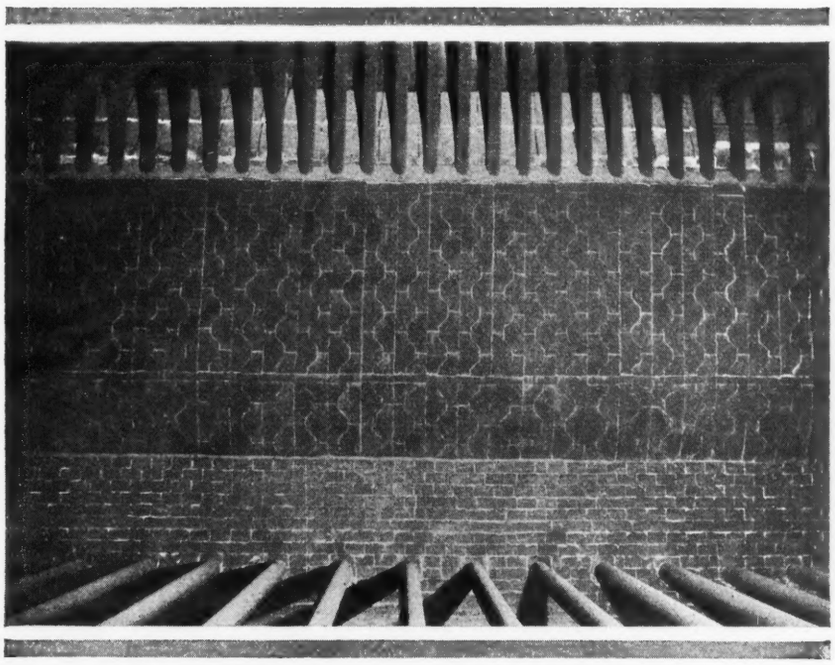
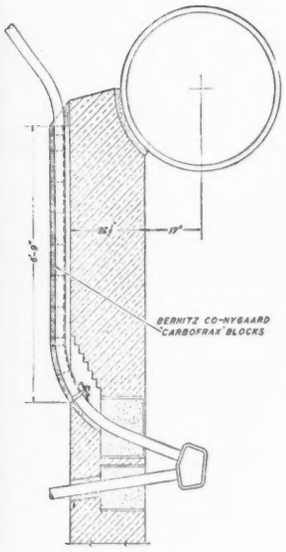


Bernitz Co.'s-Nygaard Water Wall Blocks installed on rear water wall of two 999 hp. pulverized coal fired boilers. Note how readily both the straight and the bent portions of the tubes are protected.



Sectional Elevation Rear Wall

BERNITZ CO.'S Nygaard Water Wall Blocks

Made of *"Carbofrax" material

In pulverized coal-fired furnaces, in which water walls are used, local protection against flame impingement upon the tube surfaces opposite to the burners is of vital importance.

Bernitz Co.'s-Nygaard Water Wall Blocks *are* ideal for this purpose because of their high thermal conductivity (9 to 11 times that of fire clay) and uniform heat distribution over the tube surfaces which they protect. Clinker and slag formation will not adhere and build up on this facing.

These Bernitz *"Carbofrax" Blocks provide a thermal reservoir that is instrumental in aiding combustion especially at lower ratings.

Bernitz Co.'s-Nygaard Water Wall Blocks can be installed on tubes of any size or spacing. They almost completely surround the tubes and will last permanently under the most extreme conditions. They protect the tubes and permit maximum boiler ratings to be carried continuously without detriment to the water wall tubes.

Write us for Bulletin B-71 and any specific information.

BERNITZ FURNACE APPLIANCE COMPANY

Water Wall Construction; "Carbofrax," Fire Clay, and Cast Iron Facing Blocks for new or existing water wall installations.

Main Office

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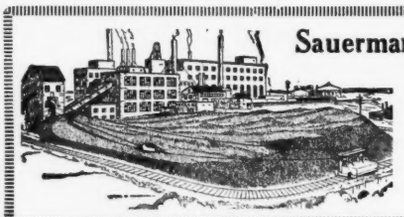
CATALOG ON REQUEST
THE MARLEY CO., Kansas City, Mo.



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Most flexible and economical method of handling fuel reserves.
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Bonds and *Extends* the life of fire brick in the best known plants of America. *Booklet PH tells how.*
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THERE IS A
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FOR EVERY
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From One Hundred to One Thousand Horsepower
THE STRONG-SCOTT MFG. CO.
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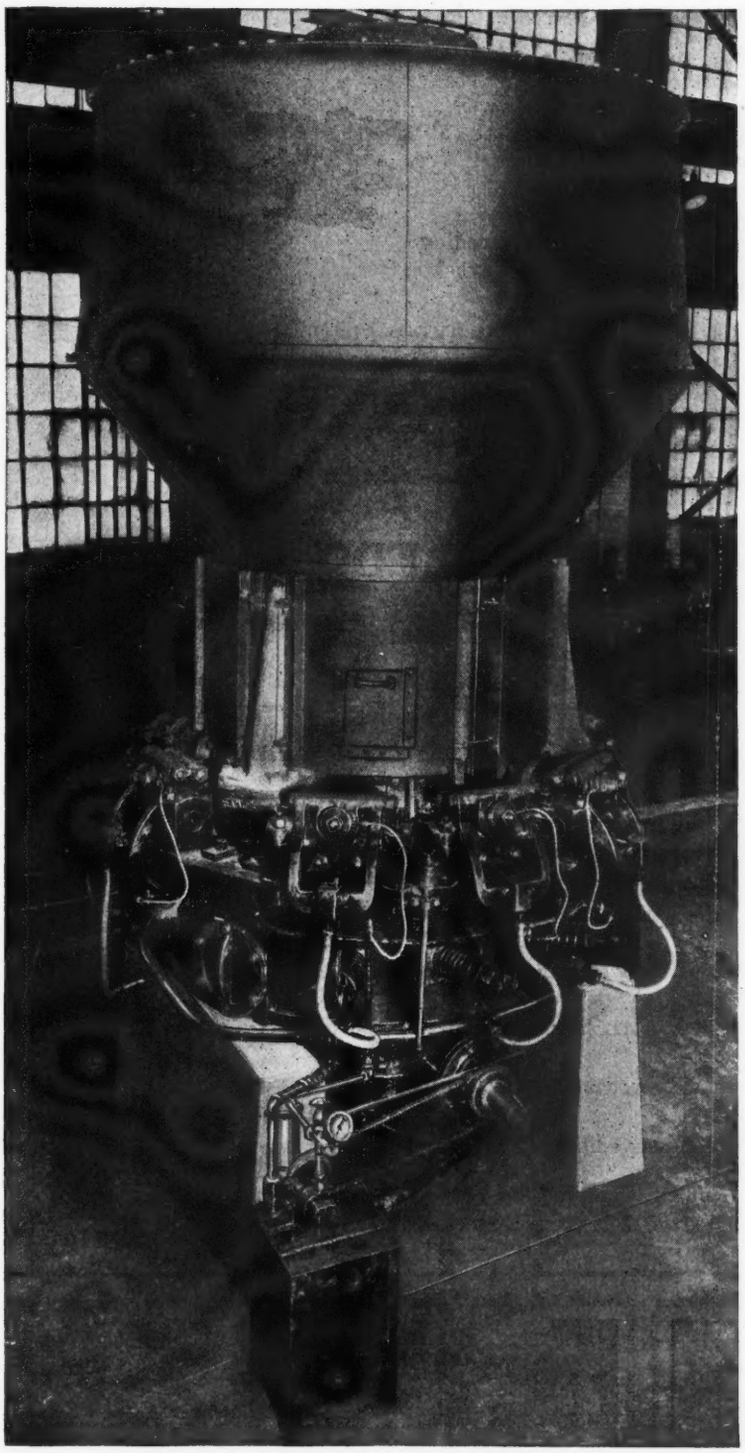
It does its job well



The Bethlehem Pulverizer does its job well regardless of the type of service you demand. You may require long, continuous performance, or short, intermittent grinding. You may grind hard, tough anthracite, or soft, brittle bituminous coal. Still the Bethlehem Pulverizer continues to deliver the desired amount of material, ground to a constantly uniform fineness.

The remarkable performance of the Bethlehem Pulverizer is due to the sound principles on which it is based, and to the special features it embodies. The machine is very heavily constructed to insure many years of hard service. A screw feeder brings a continuous flow of coal to the grinding chamber. It is the one pulverizer which always delivers fuel of uniform fineness; because, regardless of the degree of wear that may occur between the rollers and the table tracks, the area of contact remains the same.

Further, adjustments are made without stopping the machine. Repairs and replacements take less than half the time ordinarily required, due to the easy accessibility of every part. And the Bethlehem Pulverizer uses from 40 to 50 per cent less power than other machines.

Bethlehem engineers will gladly discuss the suitability of the Bethlehem Pulverizer to your requirements.

BETHLEHEM STEEL COMPANY

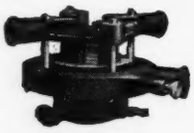
General Offices: **Bethlehem, Pa.**

District Offices: New York, Boston, Philadelphia, Baltimore, Washington, Atlanta, Pittsburgh, Buffalo, Cleveland, Cincinnati, Detroit, Chicago, St. Louis

Pacific Coast Distributor: Pacific Coast Steel Corporation, San Francisco, Los Angeles, Portland, Seattle, Honolulu.

Export Distributor: Bethlehem Steel Export Corporation, 25 Broadway, New York City.

BETHLEHEM
PULVERIZER



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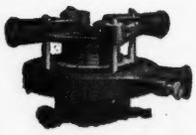
BE SURE!—INSIST ON GENUINE "TOLEDO'S"



For 30 years these original easy operating die receding tools, the "TOLEDO" No. 1 and No. 1A's have been known as the finest on the market.

Many times imitated but never equalled, these matchless little 1" to 2" threaders are the best that money can buy.

The best of materials, accurately machined and assembled by skilled workmen assure you the longest possible service.

For honest dollar for dollar value insist on GENUINE "TOLEDOS."

GENUINE "TOLEDO" No. 1's—PLAIN

"TOLEDO"

INSIST ON THIS TRADEMARK

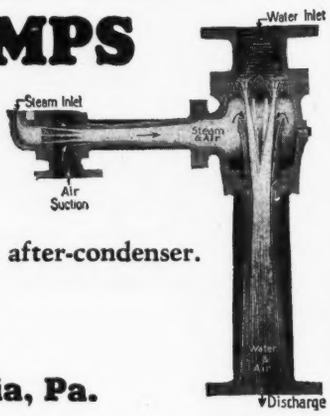
THE TOLEDO PIPE THREADING MACHINE CO. Toledo, Ohio

NEW YORK OFFICE, 72 LAFAYETTE STREET

S & K STEAM JET AIR PUMPS

for power and industrial plants

Five styles, all multi-nozzled. Five standard sizes in each style.



The S & K Hydro-Steam Air Pump pictured operates without inter- or after-condenser.

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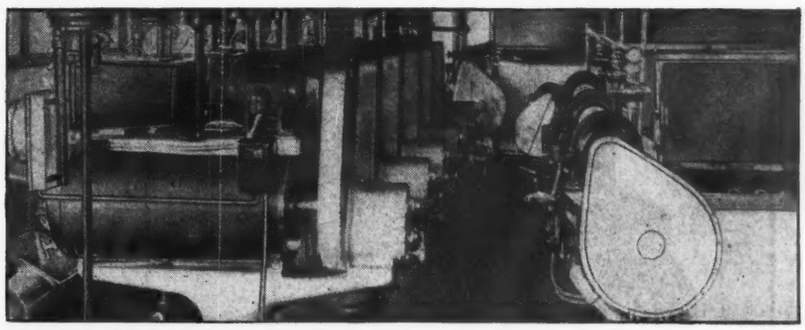
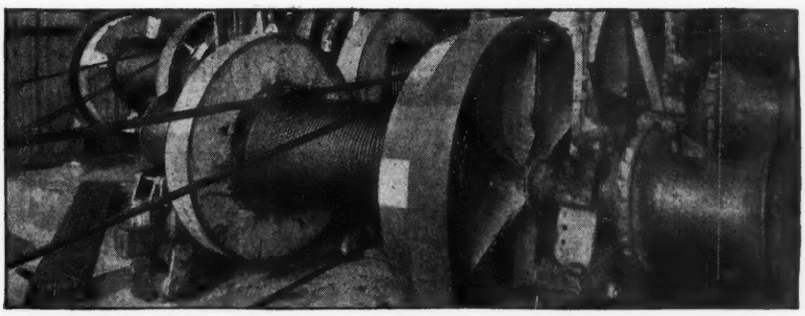
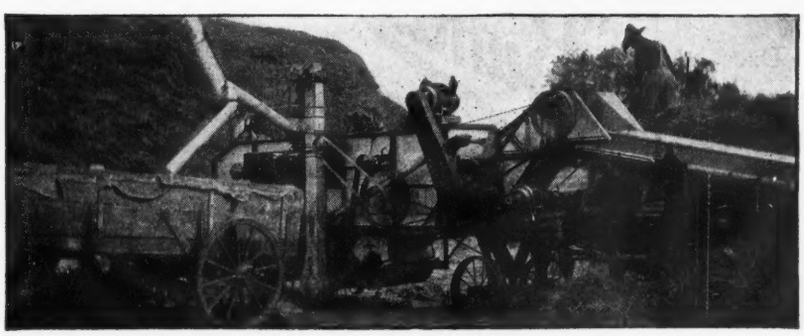




. . . Girders to hoist . . .

. . . Words to print . . .



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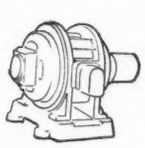
These motors will do it . . .

. . . and a thousand other things besides. The versatility of these all-around general-purpose motors from Graybar is equalled only by the versatility of the service back of them — a service that keeps not only the motors themselves, but motor specialists, too, readily available within quick reach of any point in the United States.



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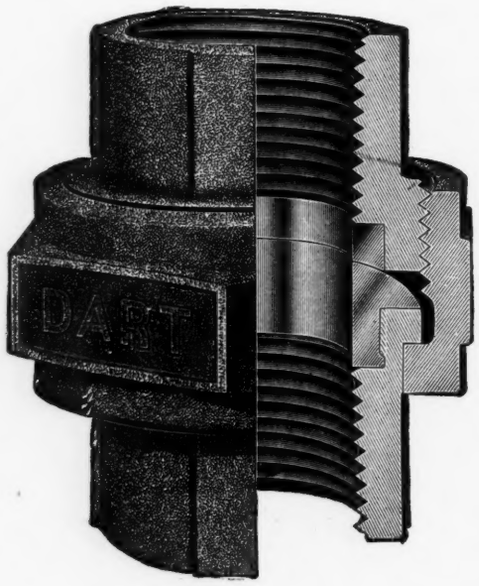

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One Dart Union will last as long as two ordinary unions. Unions last no longer than their seats. Dart Unions last twice as long as others because of the two bronze-to-bronze seats, which make up easily to a permanently tight, corrosion-proof joint.

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Capacities to 30,000 G.P.M.—Heads to 1,500 ft.

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PLATT IRON WORKS - DAYTON, OHIO.

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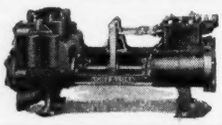

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SEWAGE EJECTORS—CENTRIFUGAL PUMPS—AIR COMPRESSORS

Jennings Pumps

NASH ENGINEERING CO. SOUTH NORWALK, CONN.

"Buffalo" Pumps

Superior Design
Efficient—Dependable

BUFFALO STEAM PUMP CO.
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POWER PLANT PIPING

We are fully equipped to supply fabricated materials and to install complete piping systems for Electric Power Stations, Blast Furnaces, Steel Mills, Coke Works, Paper Mills and Industrial Plants of every description—backed by an experience of more than a quarter century.

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A complete line of Pipe Threading machines.
Speedy—Labor-Saving—Economical
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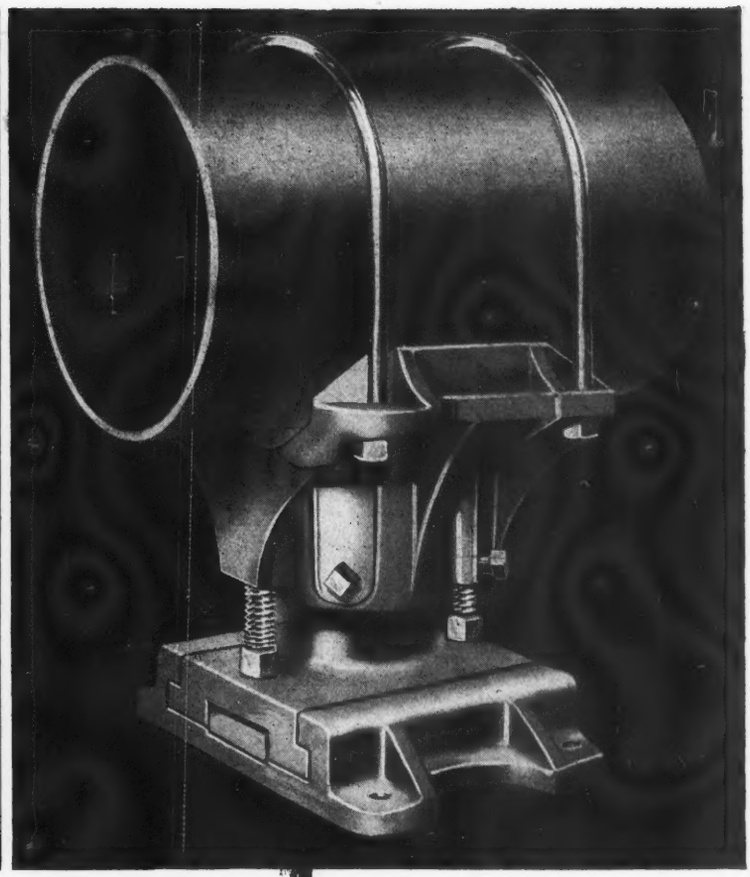
Hercules Seamless Copper Floats Last Indefinitely

Don't buy floats that wear out in a short time and have to be replaced. Hercules Floats, because of their remarkable endurance, eliminate constant renewal and repair expense.

Write for prices and details

HERCULES FLOAT WORKS
200 Franklin St., Springfield, Mass.

NAVCO "UNIVERSAL" PIPE SUPPORTS

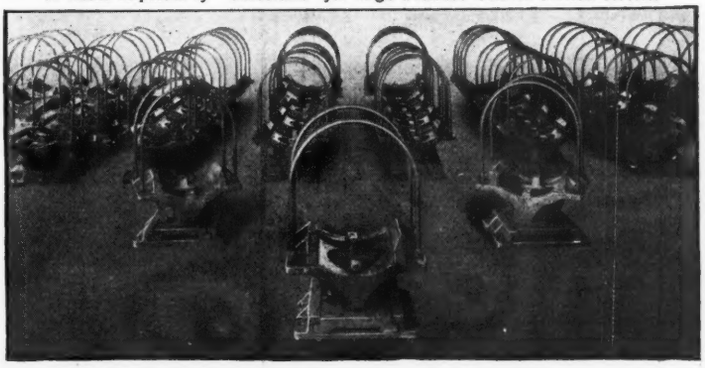


THE importance of the support of steam lines has been greatly emphasized by the present practice of operating both industrial power plants and central stations at extremely high steam pressures. This severe service has emphasized in turn the ability of the Navco "Universal" Pipe Support to meet the most exacting requirements. Here are the features:

- Constructed to care for any amount of expansion.
- Directs expansion movement to desired point.
- Permits complete insulation of pipe.
- Insulation is not disturbed by any expansion movement of pipe.
- All adjustments accessible without disturbing insulation.
- Holds the pipe down as well as up.
- Possesses means of readjustment when settlement occurs in supporting member.
- Will accommodate any angle of approach in pipe.

Your consultation with Navco Engineers on efficient and economical methods of supporting steam lines incurs no obligation whatever.

A recent shipment of "Universals" for High Pressure Central Station Service.



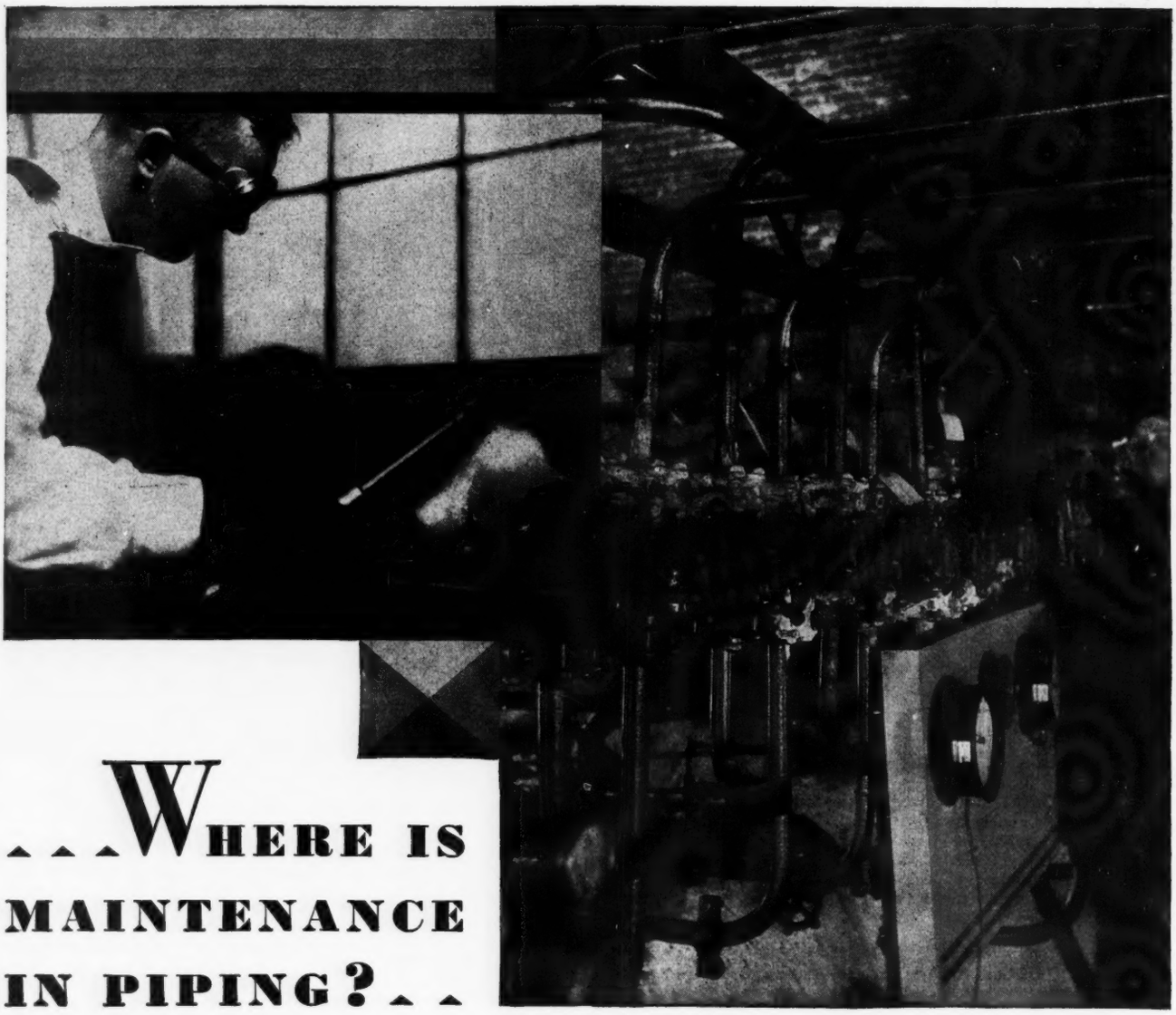
NAVCO

POWER PLANT PIPING

Navco Shops are equipped to furnish a complete power piping service, from field measurements to finished installations.

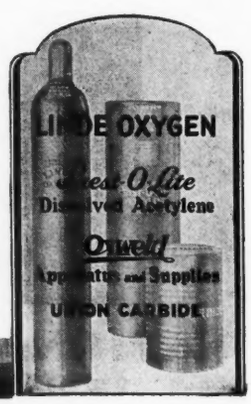
NATIONAL VALVE & MFG. CO., PITTSBURGH, PA.

[ATLANTA CLEVELAND COLUMBUS CHICAGO NEW YORK PHILADELPHIA]



. . . WHERE IS MAINTENANCE IN PIPING? . .

All maintenance and upkeep work in piping installations is at the joints. Progressive engineers, demanding the best in present day pipe fabrication, have adopted oxwelding. The oxwelded joint is strong, leakproof and permanently tight—100 per cent efficient . . . It eliminates joint maintenance.



THE LINDE AIR PRODUCTS COMPANY, THE PREST-O-LITE COMPANY, INC.,
OXWELD ACETYLENE COMPANY, UNION CARBIDE SALES COMPANY,

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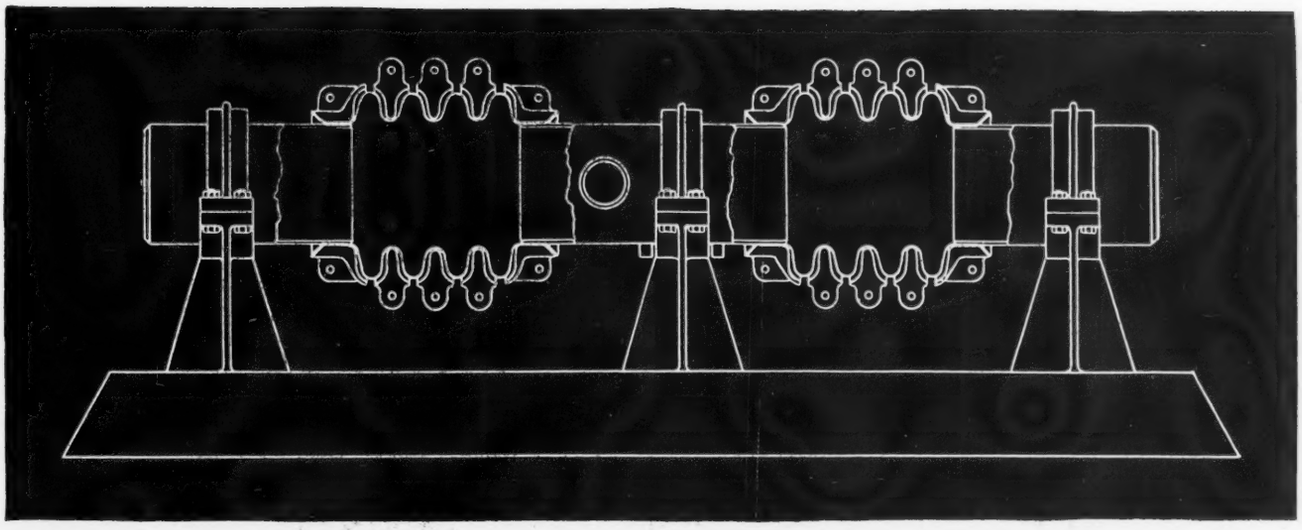
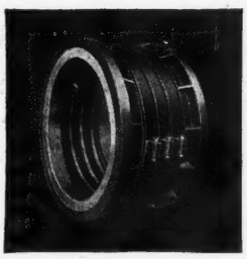


Function Like Circuit Breakers



AS is well known, circuit breakers function to protect machinery from overloads.

In much the same way the equalizing rings of Badger Joints function to protect each individual corrugation.

The rings permit flexing up to safe limits but prevent distortion. They distribute the line movement among all the corrugations.

Badger Expansion Joints are making excellent service records. To these self-equalizing rings and to the high quality deoxidized copper used much of the credit is due.

Badger Self-Equalizing Expansion Joints are available in standard units from 3″ to 30″. Both flanged end and welding types are made.

E. B. BADGER & SONS COMPANY

73 Pitts Street, Boston, Mass.

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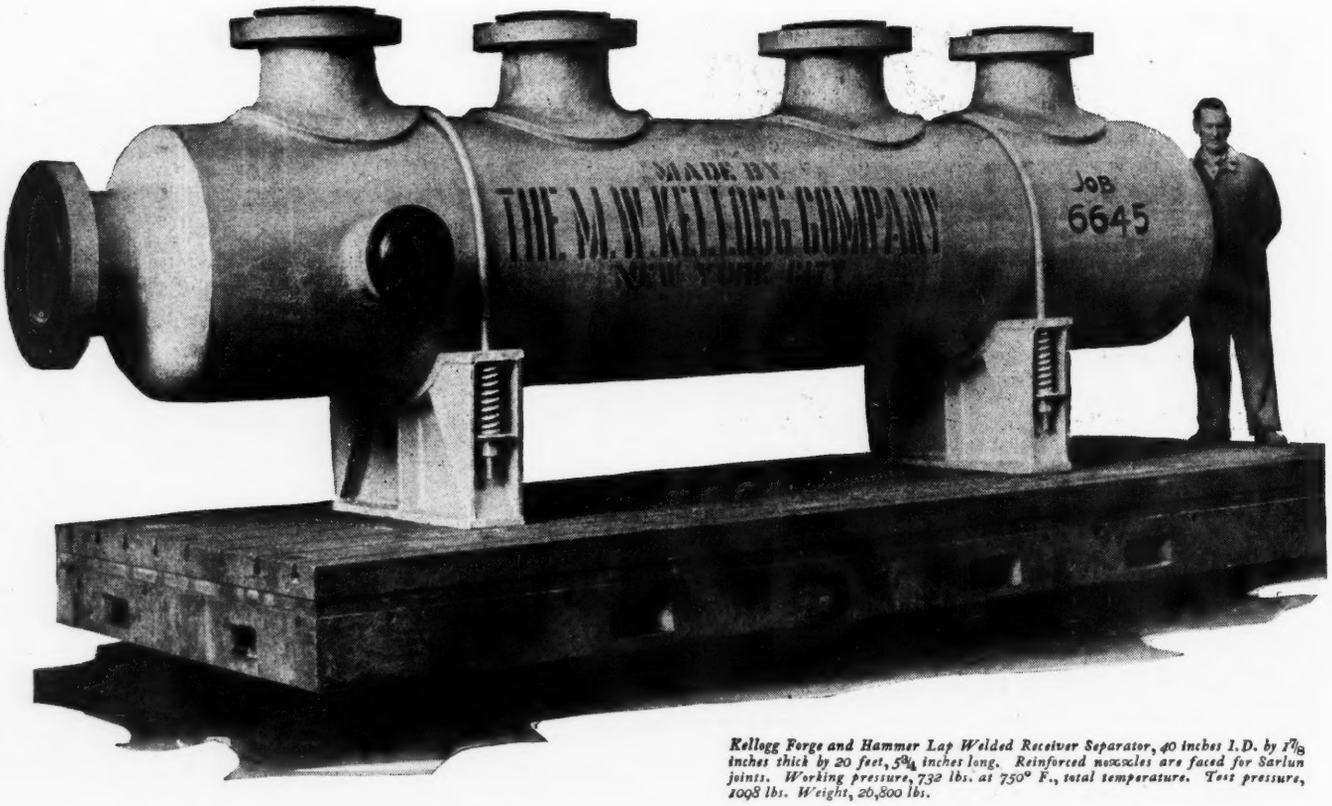
BADGER EXPANSION JOINTS



Kellogg Forge and Hammer Lap Welded Receiver Separator, 40 inches I.D. by 1 7/8 inches thick by 20 feet, 5 3/4 inches long. Reinforced nozzles are faced for Sarlun joints. Working pressure, 732 lbs. at 750° F., total temperature. Test pressure, 1098 lbs. Weight, 26,800 lbs.

Built in strict accordance *with the* A.S.M.E. *code*

KELLOGG forge and hammer lap welding invests this receiver separator with a degree of strength and reliability not obtainable in a cast or riveted unit. Built in strict accordance with the A.S.M.E. code for unfired pressure vessels, this Kellogg receiver assures long operating efficiency, safety and economy.

It was built for one of the large public utility plants in the Chicago district, and is one of many which Kellogg has furnished this company and its affiliated companies during recent years. Complete details gladly furnished on request.

THE M. W. KELLOGG COMPANY, 225 BROADWAY, NEW YORK

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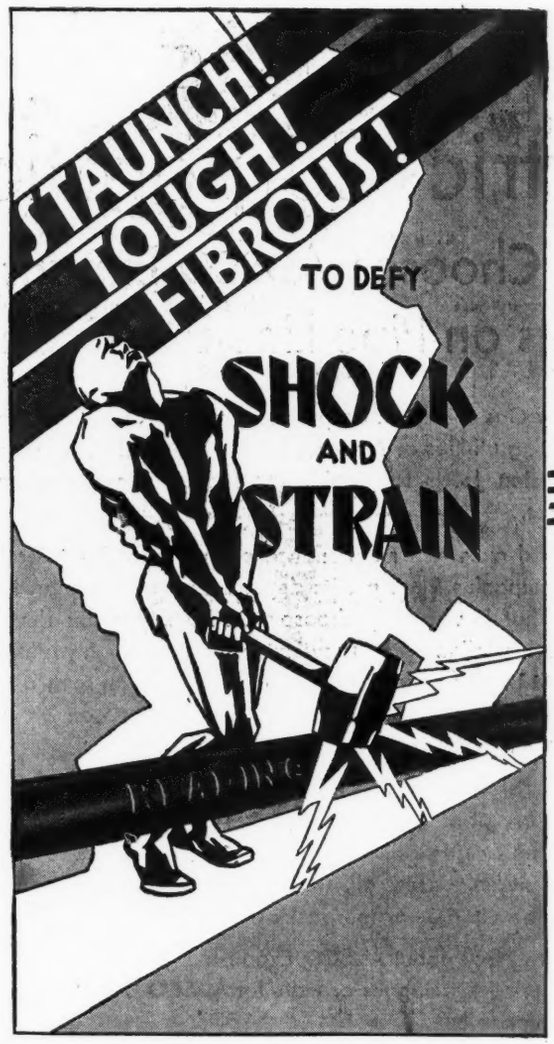
KELLOGG

FORGE AND HAMMER LAP WELDED BOILER DRUMS . . . RECEIVERS . . . SEPARATORS HEADERS . . . COMPLETE POWER PLANT PIPING

ALL KELLOGG FORGE AND HAMMER LAP WELDED PRODUCTS ARE INSURABLE



Combined with its great resistance to rust, this ability to stand up under hard knocks gives Reading 5-Point a life at least twice as long as that of ordinary pipe! Remember that Genuine Puddled Wrought Iron Pipe is the time-tested pipe—the Reading name and indented spiral assure proved performance!

Bumps, jars and rough handling mean little in the life of Reading 5-Point Pipe—the original, Genuine Puddled Wrought Iron Pipe. Thousands of installations have proved that its fibrous, rope-like structure means immunit to shock and strain.

BUILDINGS in which Reading 5-Point Pipe is used stay new! Costly repairs and replacements are eliminated. The problem of rusted-out pipe is done away with! Reading 5-Point Pipe, with its reputation for outlasting the building in which it is installed, costs only a little more initially than the cheapest pipe!

Use only Reading 5-Point Nipples with Reading 5-Point Pipe—you'll know them by the indented spiral band

For Your Protection, This Indented Spiral Forever Marks

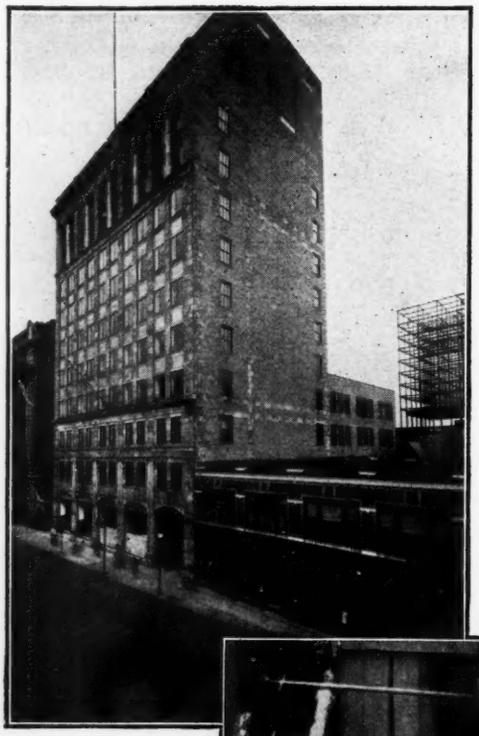
All

5 POINT PIPE
READING
GENUINE PUDDLED WROUGHT IRON

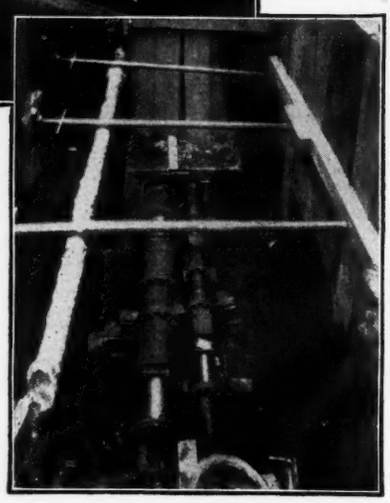
READING IRON COMPANY, Reading, Pennsylvania

GENUINE PUDDLED WROUGHT IRON
READING PIPE
DIAMETERS RANGING FROM ⅛ TO 20 INCHES

Science and Invention Have Never Found a Satisfactory Substitute for Genuine Puddled Wrought Iron



Above: View of the downtown building of the Rochester Gas & Electric Corp., whose district heating service is widely used in the business district of Rochester, N. Y.



At Right: Photo shows 10" steam main and 4" return line in this power company's steam system. Adsco Semi-Guided and Duplex Sleeve expansion joints can be seen in the foreground.

Rochester Gas and Electric Corporation

Again Chooses ADSCO Expansion Joints on Pipe Line Extensions

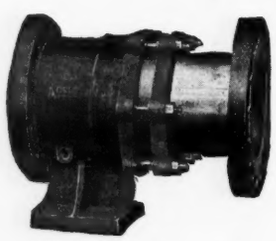
THE Rochester Gas & Electric Corporation, as well as 90% of the other district heating utilities of America, have found it advantageous to use ADSCO Expansion Joints to provide for expansion and contraction in their steam lines.

Steam leaks and excessive maintenance costs cannot be tolerated by these power companies. Their profits depend on carefree pipe line service. That is why they choose ADSCO Expansion devices for original installations and new extensions. Although you may generate a much smaller amount of steam, you can save a proportionate amount by installing these same joints on all of your important piping.

There's rarely a pipe line expansion problem that can't be solved by the use of one of the many types of ADSCO Expansion Devices. The complete line comprises joints for high or low pressure ... for steam, gases, oil, water or other fluids. They may be either the slip type or the packless type (variators).

To learn more about ADSCO Expansion Joints refer to Sweet's Engineering Catalogues or write for ADSCO bulletins illustrating the complete line.

AMERICAN DISTRICT STEAM COMPANY
GENERAL OFFICES AND WORKS
NORTH TONAWANDA, N.Y.
OVER FIFTY YEARS IN BUSINESS



Adsco Single Slip, Semi-Guided Expansion Joint

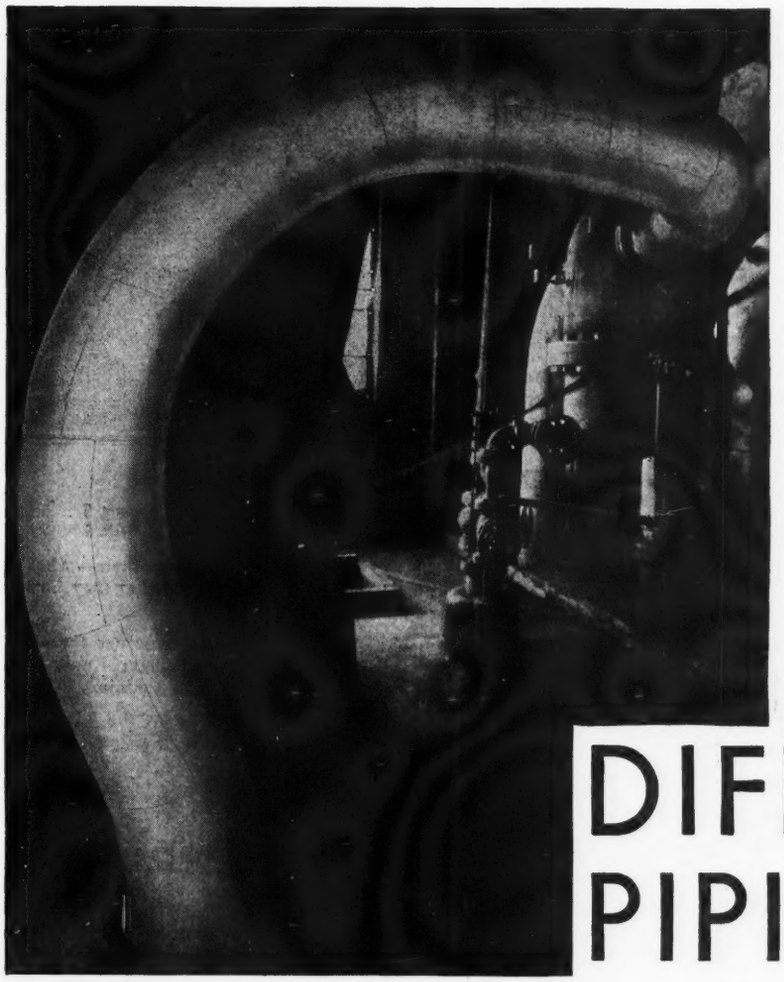
This joint, model S-8 was also used on Rochester extension. Has a total traverse of 4, 6, 8, 10, and 12 inches. Available either in double or single types. For steam, water, air or gas.

Adsco Duplex Sleeve Guided Expansion Joint

This air-cooled expansion joint, used on the Rochester job, eliminates excessive repacking costs. It is designed for pressures up to 400 lbs., and temperatures up to 750 degrees. It is constructed with an inner sleeve that is in direct contact with the steam or fluid in the pipe and an outer sleeve that bears against the packing, the two separated by an air chamber. This keeps the packing relatively cool and prolongs its life.

ADSCO
EXPANSION JOINTS

STEAM LINE EQUIPMENT, CASING, CONDUIT, CONDENSATION AND STEAMFLOW METERS AND OTHER SPECIALTIES FOR THE ECONOMICAL DISTRIBUTION OF STEAM



Complete piping in the new A. E. Staley power plant at Decatur, Illinois, was furnished by Limbert

DIFFICULT PIPING MADE TO FIT

Limbert facilities for doing the hard jobs in high pressure, high temperature piping and fittings are unequalled. Every type of high pressure joint is in regular production. Facilities for any fitting, cast or welded, are at hand. The most difficult types of bends and welded work are regular jobs for Limbert.

Limbert engineers will gladly assist you in the design and specification of your difficult piping. They can give you the benefit of a third of a century of pipe fabricating experience. They have a background of installations made in refineries and power plants the world over. You can depend on Limbert to handle your hardest job in a way that will save time and installation expense.

Use Limbert to manufacture ordinary requirements, or to design and manufacture special piping for any refinery condition.

GEO. B. LIMBERT & CO.

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Works: East Chicago, Indiana

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356 Paul Brown Building

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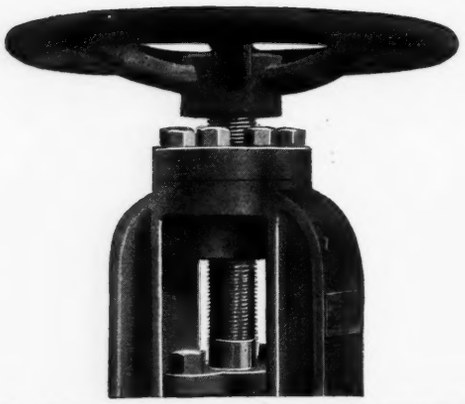

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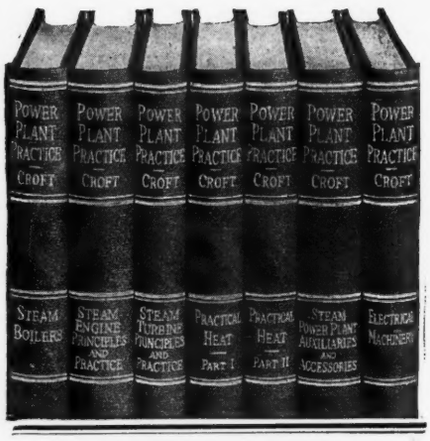
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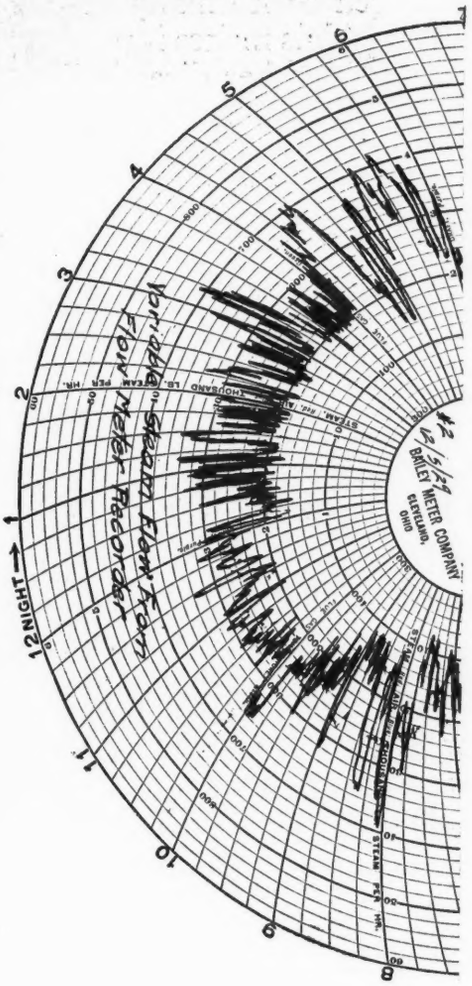

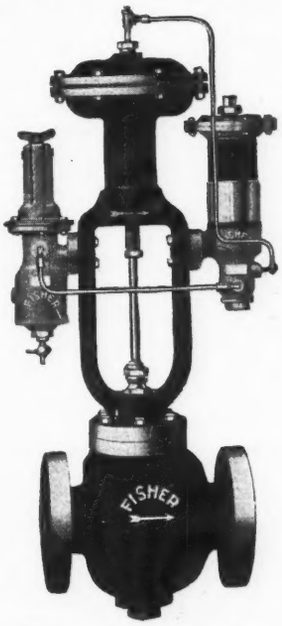

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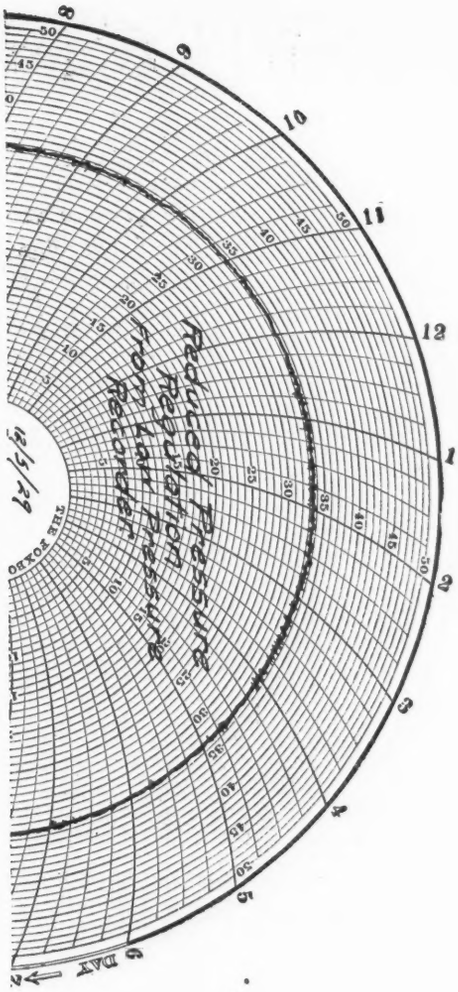

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The chart at upper right shows the accurate control of reduced pressure under these severe conditions.

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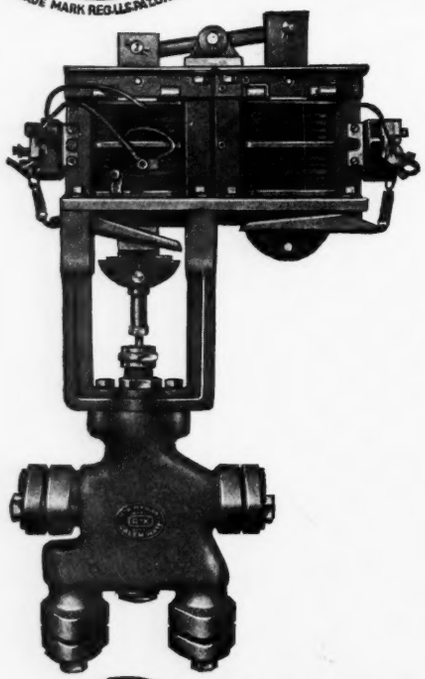

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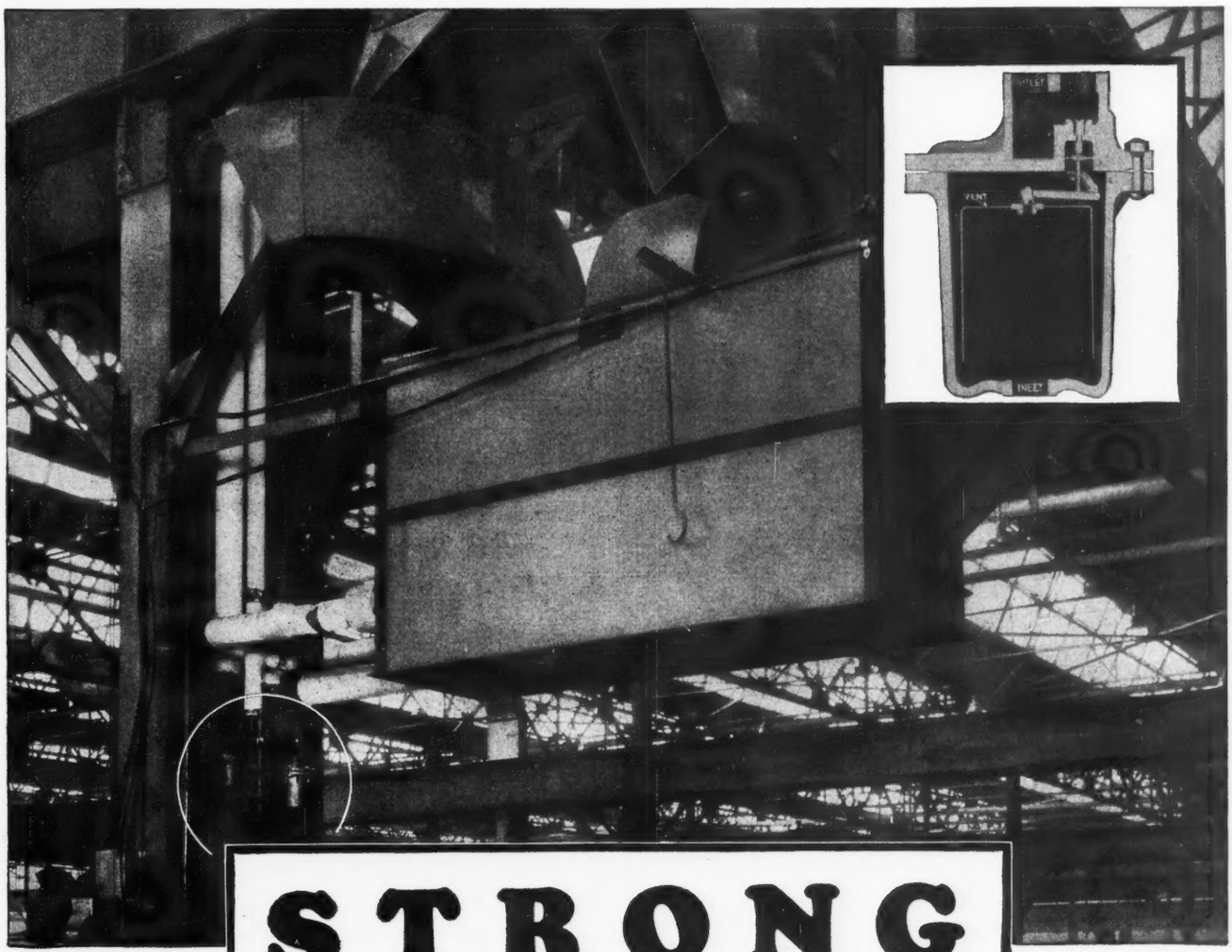

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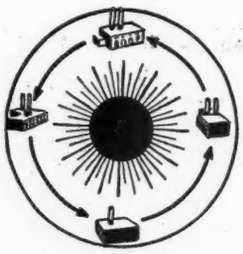

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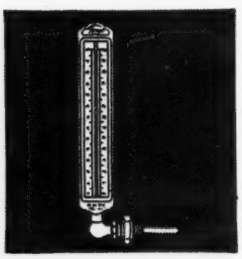

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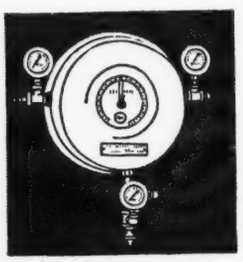

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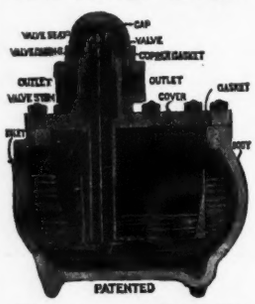

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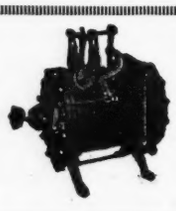

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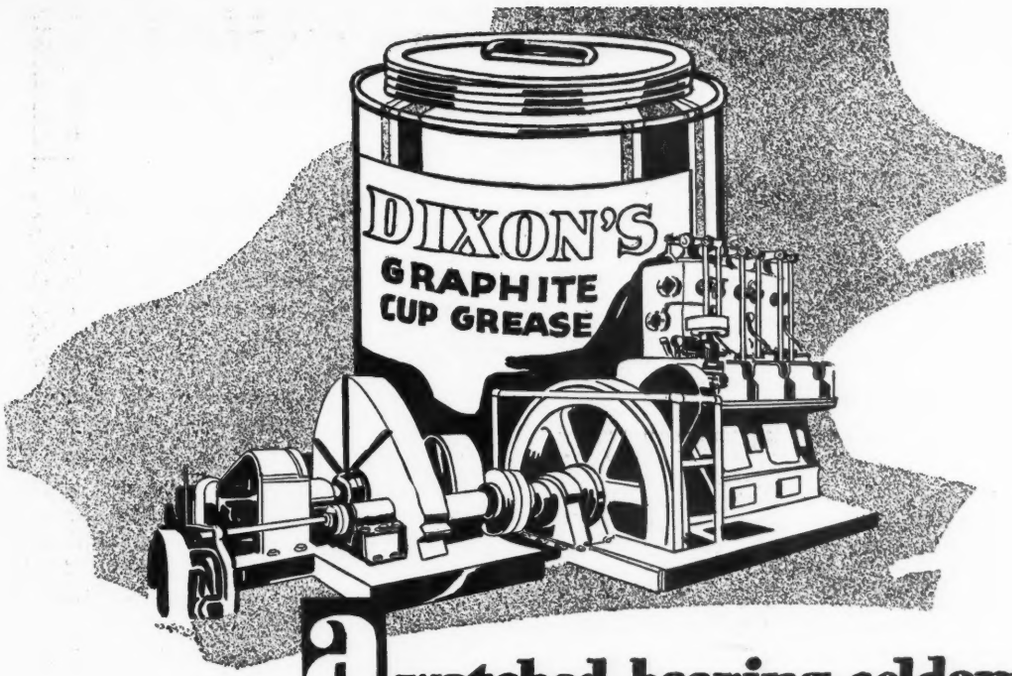

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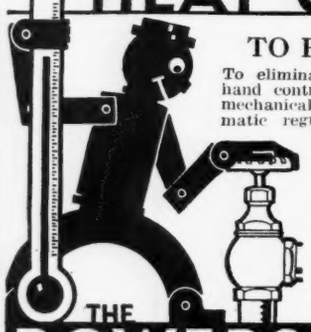

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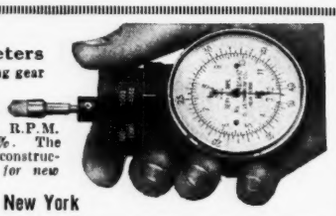

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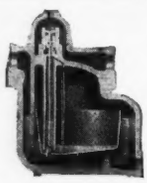

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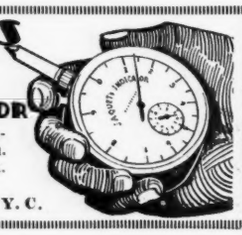

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1

"We are using Texaco Algol Oil for the lubrication of our Fairbanks-Morse Diesel Engines . . . and have been using The Texas Company's oil for the past two and a half years with the best of results. I would recommend Texaco Algol Oil to anyone for the lubrication of Fairbanks-Morse Diesel Engines."

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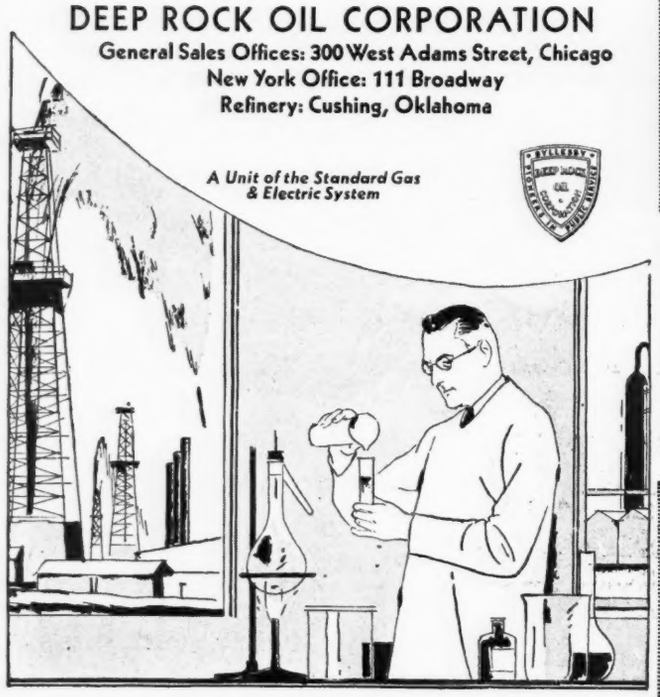

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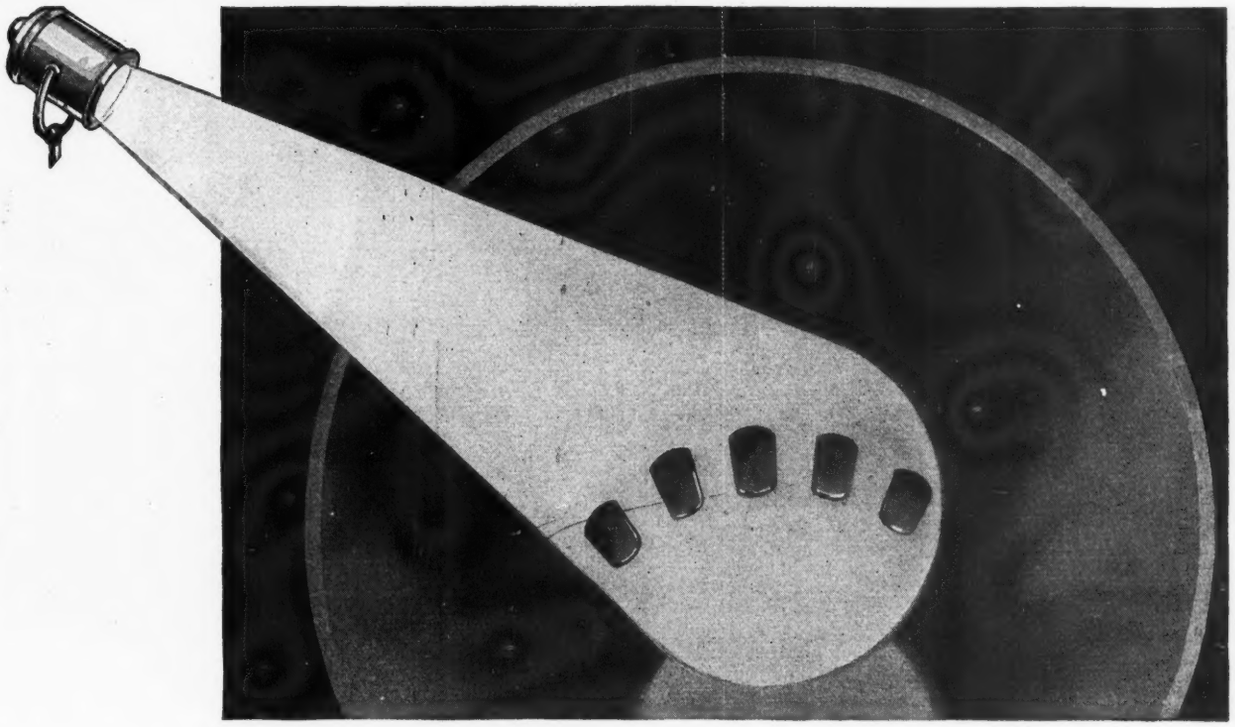

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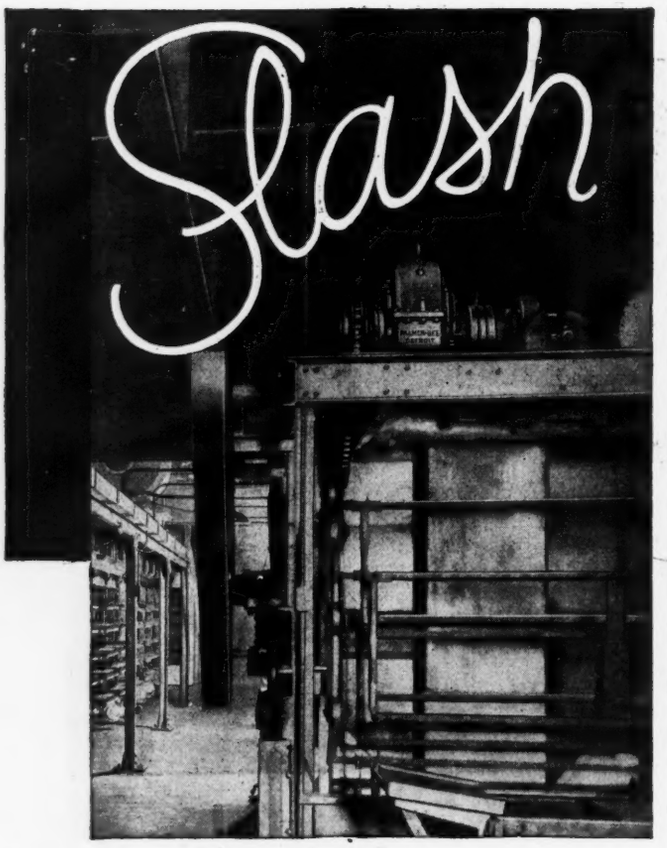
STANDARD OIL COMPANY (*Indiana*)

General Offices: **910 South Michigan Ave. Chicago, Illinois**

Chicago	Detroit	Grand Rapids	Joliet	Mason City	Saginaw	South Bend
Davenport	Duluth	Green Bay	Kansas City	Minneapolis	Sioux City	St. Louis
Decatur	Evansville	Huron	La Crosse	Milwaukee	Peoria	St. Joseph
Des Moines	Fargo	Indianapolis	Mankato	Minot	Quincy	Wichita

1306

LUBRICANTS FOR ALL INDUSTRY



POWER AND MAINTENANCE COSTS!

Right now under the cold, calm eye of stern business judgment and the lash of fierce competition, waste and extravagance of every kind are walking the plank.

Power losses and excessive maintenance, the loot of those commercial thieves, who while they may steal only a little at a time, keep everlastingly at it, are being watched as never before.

Obsolete, time-wasting and inefficient drives, the prisoners at the bar, are going the hard way.

And as the final solution to speed reducer problems, many executives are finding the answer in Palmer-Bee Herringbone Speed Reducers, the product of over twenty-five years of manufacturing experience.

With from 97 to 99% operating efficiency, absolutely vibrationless, and with shafts and gears amply oversize to provide overload capacity for starting and emergency loads, Palmer-Bee Herringbone Speed Reducers will give that trouble-proof performance demanded by the competent, up-to-date executive.

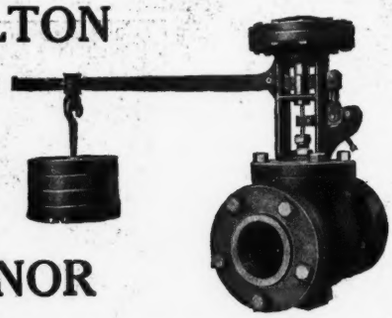
Where for one reason or another they may be preferable, we also manufacture Mill type spur gear and worm gear reducers, together with a complete line of flexible couplings.

Write us, outlining your power transmission problems, or ask for our Speed Reducer catalog.

PALMER-BEE COMPANY

1707-27 Poland Ave. - Detroit, Mich.

The FULTON Gas-Fuel BOILER GOVERNOR



Designed for steam boilers using gas for fuel. It automatically feeds the gas to the boiler furnace in such quantity as to maintain a constant given steam pressure under varying conditions of load. Hence there is no danger of over pressure of steam; nor does the steam ever fall *below* the working pressure.

It will maintain any given pressure desired, from one pound to 150 pounds or more, without attention from the engineer, no matter how frequently or how greatly the demands for steam may vary.

Write for our catalogue.

The Chaplin-Fulton Mfg. Company

28-40 Penn Ave. CF **Pittsburgh, Pa.**

Manufacturers of the Vigilant Feed-Water Regulator and other Steam Specialties

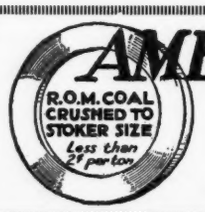
SIMPLEX METERS

SIMPLE—ACCURATE—DEPENDABLE

Write for Data

SIMPLEX VALVE & METER COMPANY

6747 Upland St., Philadelphia, Pa.



AMERICAN RING CRUSHER

Produces even sized product, resulting in uniform combustion and easier control. Results check!

American Pulverizer Co., St. Louis, Mo.

Original Manufacturers of Ring Crushers.

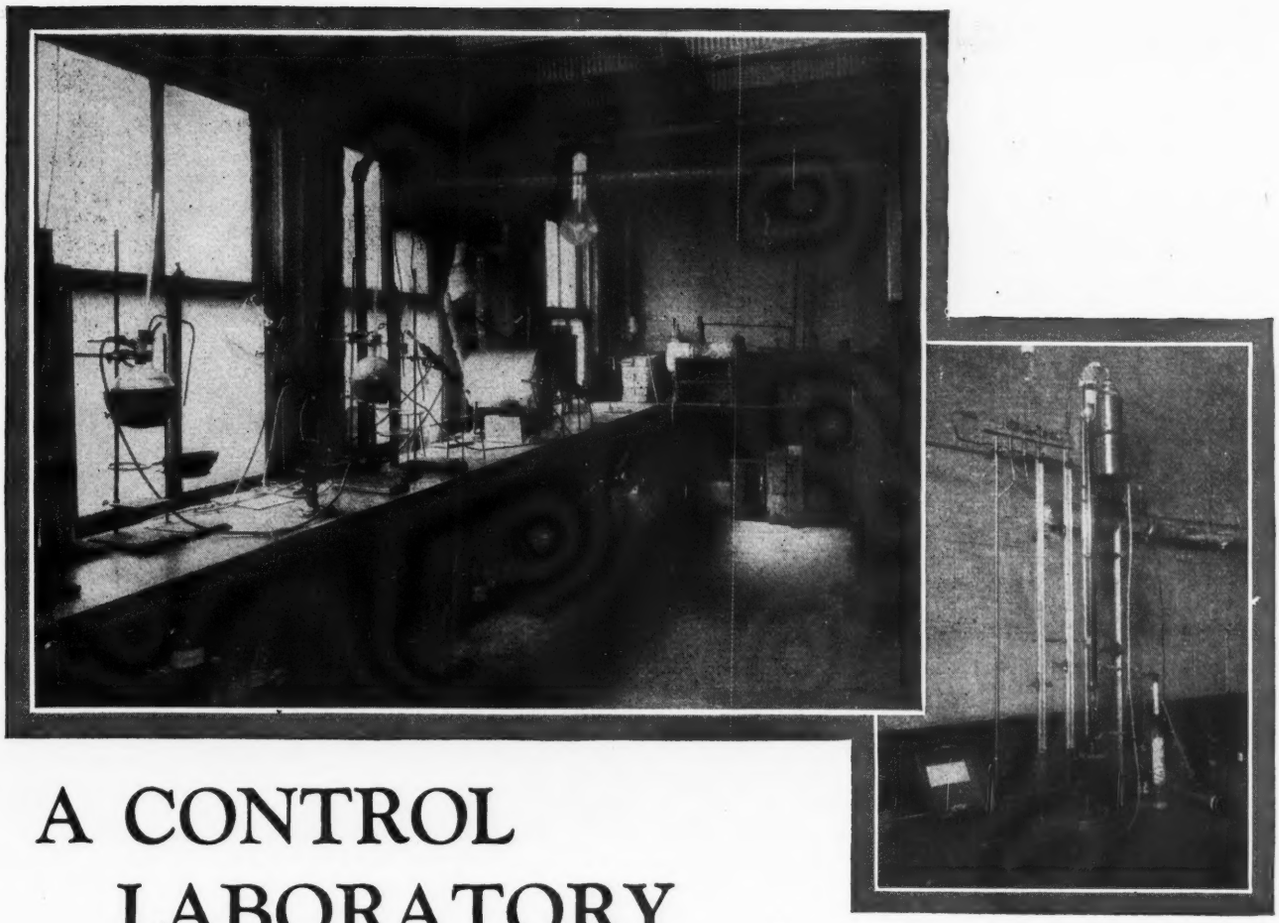
BOILER TUBES

Bent To Meet Your Needs

STANDARD WIRE & TUBE COMPANY

MINERAL RIDGE *(YOUNGSTOWN DISTRICT)* **OHIO**

Only Reliable Products Can Be Continuously Advertised



A CONTROL LABORATORY

where quality is double checked

A recent advertisement in this series discussed the continuous laboratory testing of Pure Oil lubricants at refineries.

Here is still another step to doubly assure uniform quality. The photograph above shows a corner of the research laboratory, where the work of the refinery laboratories is continually checked, both as to methods and condition of equipment and for quality of products.

In addition, a large staff of highly skilled technically-trained men is maintained here for research work, to develop better lubricants for each of the many services for which lubricants are used. The growing popularity of PURE OIL lubricants in industrial service is based upon good products and good service. Enlist their services for your plant. 'Phone, wire, or write nearest sales office.

THE PURE OIL COMPANY

U. S. A.

Producers, Refiners, Marketers of a complete line of petroleum products

★ REFINERIES: ★

Marcus Hook, Pa. Heath, Ohio Muskogee, Okla. Ardmore, Okla. Smith's Bluff, Texas
Cabin Creek Jct., W. Va.

★ SALES OFFICES: ★

Chicago, Ill.	Pittsburgh, Pa.	Minneapolis, Minn.	Columbus, Ohio	New York, N. Y.
Bethlehem, Pa.	Charleston, W. Va.	St. Paul, Minn.	Akron, Ohio	Syracuse, N. Y.
Philadelphia, Pa.	Wheeling, W. Va.	Canton, Ohio	Cincinnati, Ohio	Troy, N. Y.
Wilkes-Barre, Pa.	Binghamton, N. Y.	Indianapolis, Ind.	Dayton, Ohio	Utica, N. Y.

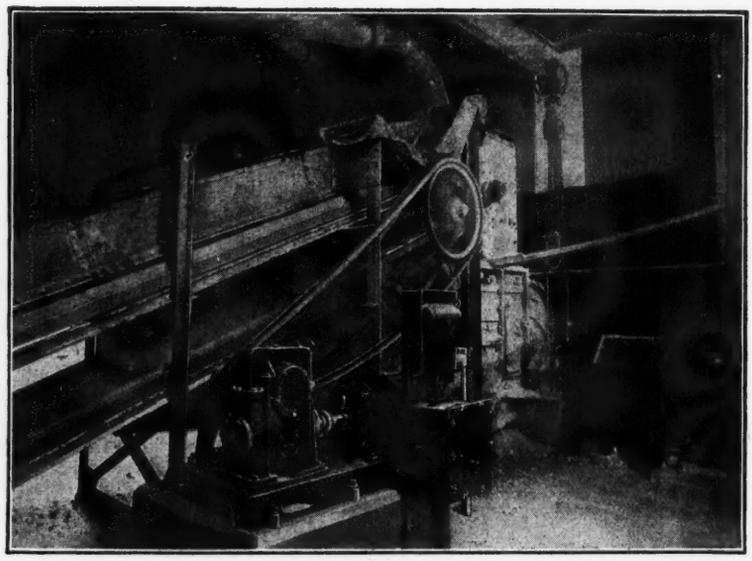
Save Power—with Philadelphia SPEED REDUCING UNITS

(ONE NAME-ALL TYPES)

The average open gear train reduction device consumes about 25% of the power generated by the prime mover, is hard to lubricate, on account of being exposed to dirt, moisture, grit, etc. This results in excessive wear, which produces vibration and pounding,—with resultant short life.

Philadelphia Speed Reducing Units deliver a "high precentage of applied power", because every precaution has been taken to reduce friction to a minimum. Ball or Roller Bearings (or both) as the service requires, are used on shafts,—while all moving parts operate in an "oil bath". Another advantage: All gears used in Philadelphia Units have "perfect tooth contact" and are made of the highest grade metals obtainable, properly treated for resistance to wear.

Remember we make ALL types of Speed Reducers, under one name—"Philadelphia". The result of nearly 50 years' GEAR MAKING experience.



Type AT—Size 1059 Worm Unit driving a conveyor in a well known Cement Mill. Hp. 15—900 r.p.m.—ratio 15 2/3:1.

Main Office and Plant Erie Ave. and G St. Phila., Pa.

PHILADELPHIA GEAR WORKS

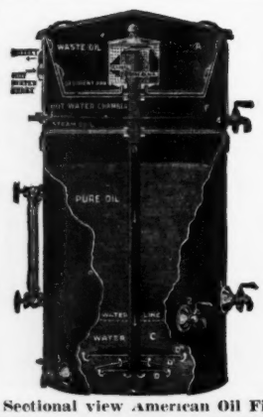
Manufacturers of Industrial Gears and Speed Reducing Units

PHILADELPHIA, PENNA.

Branch Sales and Engineering Offices

New York, 12 E. 41st Street

Pittsburgh, Pa., Farmers Bank Bldg.



Sectional view American Oil Filter

OIL FILTERS

FOR EVERY INDUSTRIAL REQUIREMENT

The new booklet on Burt Oil Filters contains an abundance of useful and interesting facts about the filtration of waste oil. Each type of Burt Filter is completely described giving prices, capacities, etc. Your copy will be mailed on request.

THE BURT MFG. CO.

Ventilators — Oil Filters — Exhaust Heads

232 Main St., Akron, Ohio

You can't pick the corners off—

SKOOKUM

(patented)

cross expansion piston rod packing

Skookum corners won't even break off in the stuffing box. Write for free working sample.

Pioneer Rubber Mills

New York *Chicago* *San Francisco*

Clip This Ad.

to your letterhead. We will send folder giving sizes and prices.

"Flexitallic"

"Flexitallic" Gasket Co.

Camden, N. J.

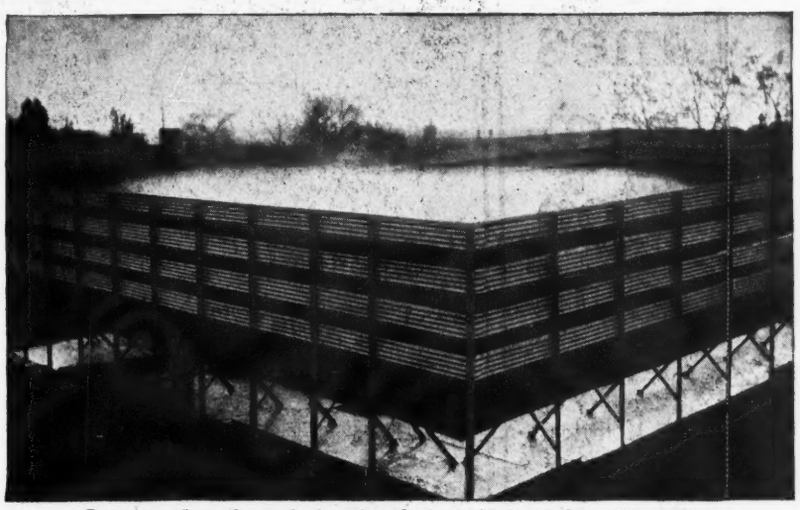
METALLO GASKETS

Indestructible asbestos cord laid in circular groove by protecting cover of copper is the basis of the Metallo Gasket—a gasket that is making an enviable record under the severest conditions. Write for ILLUSTRATED catalog and free samples.

METALLO GASKET COMPANY

New Brunswick, N. J.

Who said you needed a 10 acre lot?



Spraco pond on the roof of an ice plant. Paid for itself in 18 months.

Put a Spraco Cooling System on your roof . . .

Since 1913, Spraco has been installing spray cooling systems on plant roofs.

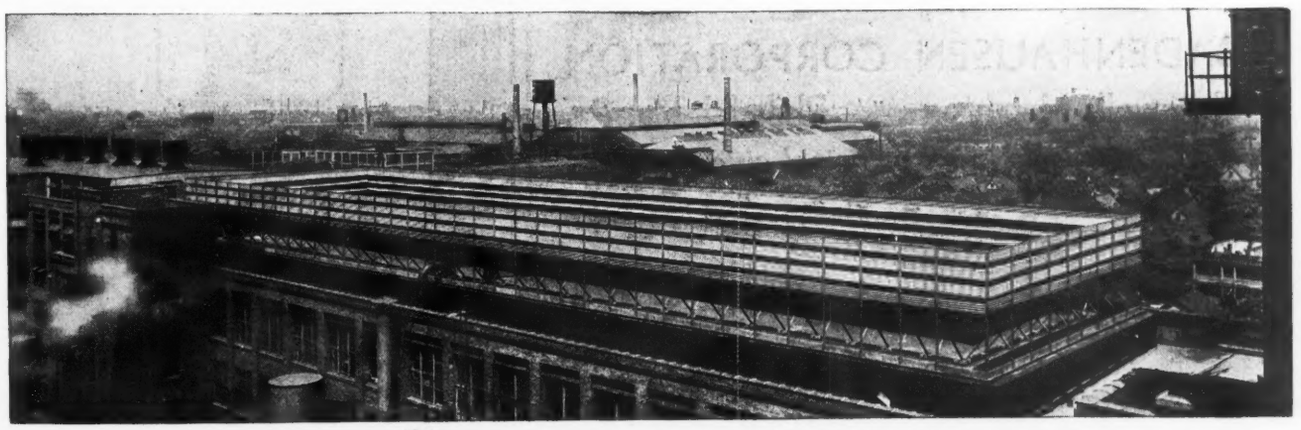
They cost less than a tower to erect and maintain, and cooling results exceed those obtained by other systems due to uniform distribution and fineness of spray produced by patented Spraco nozzles.

The roof is easily prepared by removing loose gravel and applying one or two extra moppings of high grade roofing compound. Spraco metal louvre fence effectively prevents spray drift, has very little effect on cooling efficiency and a gale of 60 m.p.h. will not blow it down. The lightest roof which meets building requirements will carry the fence.

Cut the cost of cooling condensing or circulating water by installing a Spraco system on your roof. Send the coupon.

Please send Bulletin 392 describing Spraco cooling system.

Mr. .....
Firm .....
Street .....
City ..... State .....



Spraco metal louvre fence around a spray pond on the roof of a Cleveland manufacturer, 186 ft. long by 43 ft. wide, serving 5000 kw. Turbine.

SPRACO
INCORPORATED
SUCCESSORS TO SPRAY ENGINEERING CO.
120 CENTRAL STREET SOMERVILLE, MASS.

4135

Long Steam Lines Superheated Steam Less Condensation Lower Fuel Costs

The pipe lines from the Lewis Jones, Inc. Central Heating Plant in the fashionable Overbrook Colony at Philadelphia extend as far as two and one-half miles. In lines this long, rapid condensation and great loss of heat would result were it not for the Badenhausen Boilers and the *dry steam* they deliver, superheated 20 to 30 deg. F. With this superheat there is little condensation and fuel costs are kept down. In fact the first Badenhausen Boiler installed here reduced coal consumption 20% as compared with the old boilers.

So completely satisfactory was this first Badenhausen unit that the Overbrook installation has grown as follows:—

1919—1— 600 hp. boiler
1922—1—1000 hp. boiler
1925—1—1000 hp. boiler
1927—1—1200 hp. boiler
1929—1—1400 hp. boiler

Badenhausen installations increase because Badenhausen equipment is satisfactory—this is only one of many instances. Why not get the complete Badenhausen story?

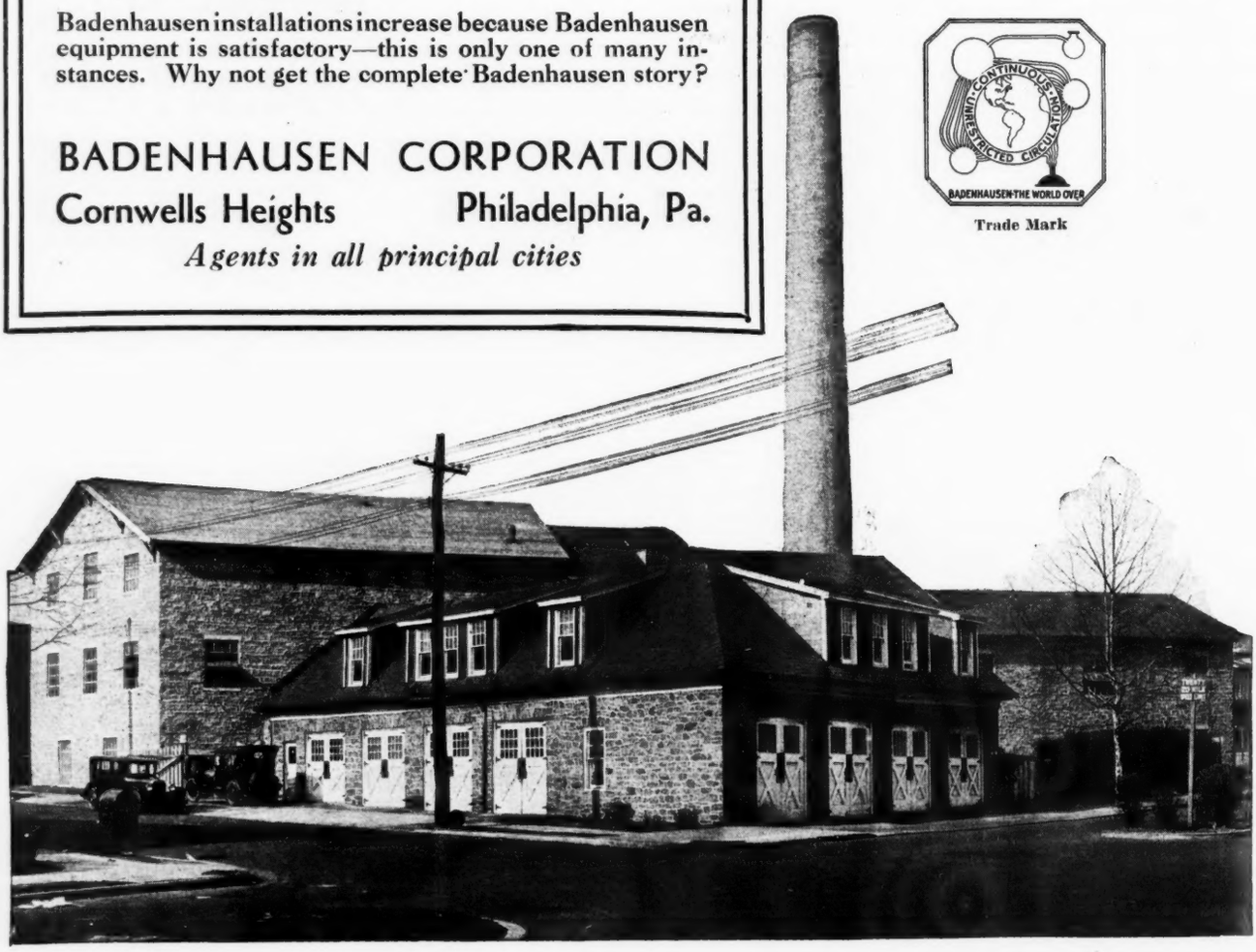
BADENHAUSEN CORPORATION
Cornwells Heights Philadelphia, Pa.
Agents in all principal cities

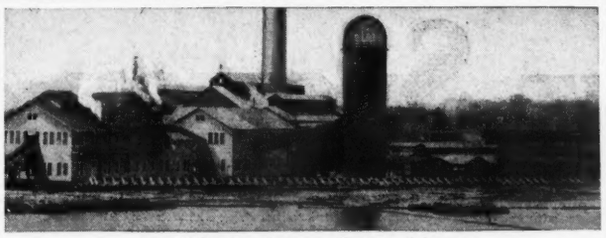
HIGH EFFICIENCY

HIGH CAPACITY

ECONOMICAL OPERATION

CONTINUOUS UNRESTRICTED CIRCULATION
BADENHAUSEN-THE WORLD OVER
Trade Mark





Crossett Lumber Company, Crossett, Arkansas

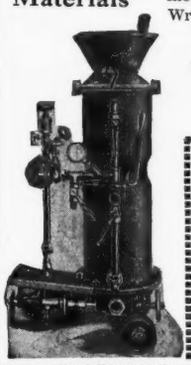
THE CEMENT-GUN TRADE MARK serves all industries

Handles DRY Materials

This lumber mill is typical . . . the "Cement Gun" will save money in your plant, similar to those it is effecting in hundreds of other concerns.

Use it for repair and maintenance work! Use it to avoid lengthy boiler shutdowns. It will save its cost in one or two jobs. Our Contract Department will do the work for you.

Write for Bulletin 139A giving full details.



Cement-Gun Company, Inc.
Allentown, Penna.

Cement-Gun Co., Inc.
Allentown, Penna.

Without obligation, I will be pleased to receive your new 16-page, 6 by 9 in. bulletin 139-A giving the many ways of reducing costs of furnace linings, baffles, chimneys, coal bunkers.

Name .....
Address .....
City .....
State .....

DIAMOND SOOT BLOWERS

Please write for bulletin on boiler cleaning by modern methods.

DIAMOND POWER SPECIALTY CORPORATION·DETROIT

DODGE

MISHAWAKA

DODGE MANUFACTURING CORPORATION
Mishawaka, Indiana
The World's Marketplace for Industrial Equipment

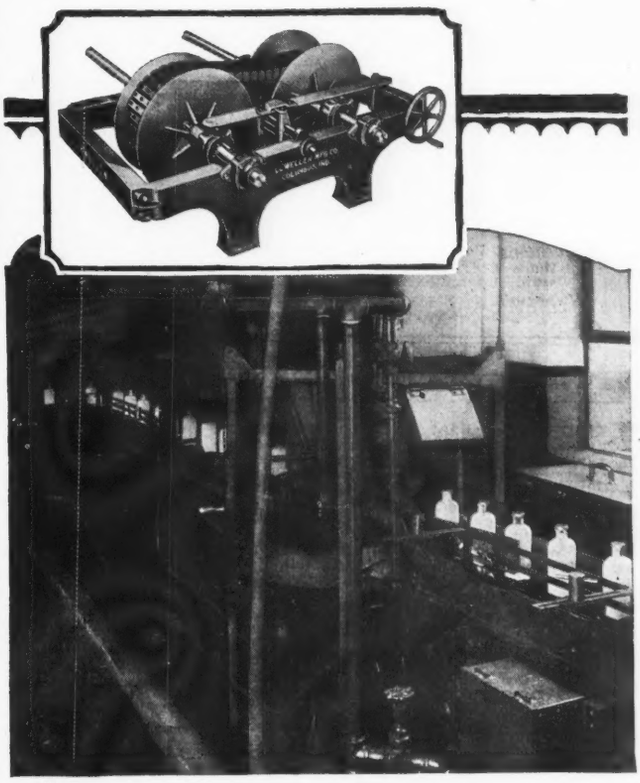
FRANCE

Metallic Packings of the Better Class

Ideal for superheated or saturated steam, ammonia, air or gas for all pressures and operating conditions. Last 5 to 25 years. Sold on approval.

Write for catalog and list of users.

FRANCE PACKING COMPANY
6600 Tacony St., Philadelphia, Pa.



CONTROLLED speed is the basic principle of modern production. In this filling and packaging line, as in hundreds of other applications, the LEWELLEN Variable Speed Transmission synchronizes operations, saving time, avoiding waste, and speeding up production.

Every power-driven conveyor needs the LEWELLEN Transmission, to make it most efficient. Put a LEWELLEN on your conveyor, and see the improvement.

LEWELLEN
VARIABLE SPEED
TRANSMISSION

If you do not have our latest catalog No. 25 we shall be glad to furnish it, upon your request.

LEWELLEN MANUFACTURING CO

COLUMBUS·INDIANA

SEARCHLIGHT SECTION

EMPLOYMENT AND BUSINESS OPPORTUNITIES—USED AND SURPLUS NEW EQUIPMENT

UNDISPLAYED—RATE PER WORD:

Positions Wanted, 5 cents a word, minimum $1.00 an insertion, payable in advance.

Positions Vacant and all other classifications, excepting Equipment, 10 cents a word, minimum charge $2.00.

Proposals, 40 cents a line an insertion.

INFORMATION:

Box Numbers in care of our New York, Chicago or San Francisco offices count 10 words additional in undisplayed ads.

Discount of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

DISPLAYED—RATE PER INCH:

1 to 3 inches.....$6.00 an inch
4 to 7 inches..... 5.75 an inch
8 to 14 inches..... 5.50 an inch

Other spaces and contract rates on request.

An advertising inch is measured vertically on one column, 3 columns—30 inches—to a page. Power

COPY FOR NEW ADVERTISEMENTS RECEIVED UNTIL 5 P.M. WEDNESDAY FOR TUESDAY'S ISSUE.

EMPLOYMENT SERVICE

IF YOU are qualified for position between $2,500 and $25,000 and are receptive to negotiations for new connection, your response to this announcement is invited. The undersigned provides a thoroughly organized service, established twenty years ago, to conduct confidential preliminaries, and assist the qualified man in locating the particular position he desires. Not a registration bureau. Retaining fee protected by refund provision, as stipulated in our agreement. Send name and address only for description of service. R. W. Bixby, Inc., 270 Main Street, Buffalo, New York.

POSITION WANTED

CHIEF engineer with technical and practical knowledge in economical and efficient installation, maintenance and operation in steam, electric and power plants, desires position. Gold Seal license. John Zschocke, 27 Budd St., Morristown, N. J.

REPRESENTATIVES WANTED

Sales Representatives

Who can produce to complete our sales organization in exclusive open territories: commission only. Syrosil is an established refractory lining for industrial and steam boiler furnaces. Used by Studebaker and other large firms. It is infusible at 3,400 deg. F., resists slag and iron oxide. Syrosil Company, Elkhart, Ind.

SALESMAN WANTED

Metropolitan Area

Established trade and product for industrials, jobbers, large earnings, paid in full weekly. Exceptional opportunity for one who means business. Replies confidential. SW-944, Power, Tenth Ave. at 36th St., New York.

PATENT ATTORNEY

PATENTS: Free information on patenting new inventions. Free booklet and blanks. Inquiries personally answered. Sterling Buck, 699 F. Washington, D. C.

WANTED

CORPORATION located in New York has opening for

PATENT ATTORNEY

with Patent Office experience and also experience in patent soliciting. Engineering experience particularly along combustion and heat transfer lines desirable. Write stating age, training, experience, present location and salary required.

P-947, Power
Tenth Ave. at 36th St., New York City

TURBINES

100-hp. **Terry Turbine** with gears. Speed 3950/860 r.p.m. For 160 lbs. steam pressure, 50° superheat and 2 lbs. back pressure.

Absolutely New—Never Been Used.
$1,000 "as is" f.o.b. cars, Jeannette, Pa.

180-hp. **Moore Turbine** with gears. Speed 3380/860 r.p.m. For 130 lbs. steam pressure, 0° superheat and 1 lb. back pressure.

Used — but in good condition — $500 "as is" f.o.b. cars, Jeannette, Pa.

ELLIOTT COMPANY
Jeannette, Pa.

Used Power Equipment

Bought, Sold, Installed by Specialists

Power Plant Installations

Purchasing and Inspection Commissions Executed

Bank and Mortgagees' Appraisements

W. H. HACKETT
Room 3411, 452 Lexington Ave., N. Y. C.
(Phone Murray Hill 2267)

Notice To Advertisers!

Owing to the Holiday, July 4th, the *"Searchlight"* pages of the July 8th issue of

POWER

will close one day in advance of the regular schedule.

Advertisers will be cooperating with us by sending new advertisements or changes of copy early.

FINAL CLOSING TIME
5 P.M. Tuesday, July 1st.

Agents
Salesmen
Representatives
Selling Opportunities

You can find them all through an ad in the

SEARCHLIGHT SECTION

Your ad here will have the attention of the whole industry and the cost is small.

For Every Business Want
"Think* SEARCHLIGHT *First"

TURBO GENERATORS

1—3750 kva., G.E. with surface condenser.
1—1500 kva., G.E. extraction type.
1—1000 kva., G.E. with Alberger Condenser.
1—625 kva., G.E. with jet condenser.
2—300 kva., G.E. with condensers.
1—250 kva., Westinghouse non-condensing.
2—100 kva., G.E.
1—94 kva., Westinghouse.
1—75 kva., Allis-Chalmers.

60 CYCLE A.C. ENGINE UNITS

1—50 kva. to Ridgway.
2—75 kva. to Ames.
1—80 kva. to Skinner.
1—125 kva. to Skinner.
1—125 kva. to Hamilton Corliss.
1—150 kva. to Chuse Unaflow.
1—150 kva. to Harrisburg 4 valve.
1—156 kva. to Skinner Unaflow.
1—180 kva. to Skinner Unaflow.
1—240 kva. to Harrisburg, 4 valve.
1—250 kva. to Ridgway Unaflow.

FAIRBANKS DIESEL UNITS

2—35 kva., 3 ph., 60 cy., 220 volt. to Type "Y" oil engines with exciters and panels.

MOTOR GENERATORS

1—500 kw., 250 v. G.E. gen. to 700 hp., 3 ph., 60 cy. syn. motor.
1—150 kw., 550 v. "SK" Westgh. gen. to syn. motor.
1—90 kw., 250 v. G.E. gen. to 150 hp., 3 ph., 60 cy. syn. motor.
1—70 kw., 240 v. G.E. gen. to 125 hp., 3 ph., 60 cy. syn. motor.

STATIC CONDENSERS

1—150 kva. G.E.—1—200 kva. G.E.

SPECIAL

10—250 hp., 3 ph., 60 cy., 2300 v., 585 r.p.m. Crocker-Wheeler slip ring motor with oil, switch, controller and resistance—$800 each.

WATER WHEELS & GENERATORS

5—Leffel wheels to 250 to 450 kw. gen.

NEW WESTGH. SYN. MOTORS

Sizes from 125 to 575 hp.

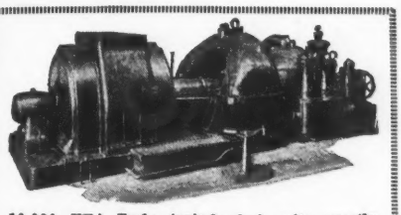
MOTORS

Thousands of them in all sizes and for various electrical circuits.

WHAT DO YOU WANT? *WHAT HAVE YOU FOR SALE?*

GEORGE SACHSENMAIER CO.

8403 Hegerman Street, Holmesburg, Philadelphia, Pa.



10,000 KVA Turbo typical of 4 units recently delivered and similar to the following.

PRACTICALLY NEW 100% INTERNAL EXCELLENCE WESTINGHOUSE CONDENSING TURBO UNITS COMPLETE—INSTANT SHIPMENT

1—15,000 KW CW-218 Frame—1800 RPM
1—10,000 KVA CW-118 Frame—1800 RPM
1— 7,500 KW CW- 78 Frame—1800 RPM
1— 5,500 KVA CW- 76 Frame—3600 RPM
1— 4,000 KVA CW- 76 Frame—3600 RPM
2— 1,700 KVA CW- 26 Frame—3600 RPM
1— 1,500 KVA CW- 16 Frame—3600 RPM
(3 phase, 60 cycle, standard voltages)

A.S.M.E. CODE DESIGN BOILERS 200-225 lbs.

2—1500 H.P. Cross Drum B & W
2—2650 HP. Ladd Bent Tube
5— 627 HP Stirling Plant, modern stokers, auxiliaries
8— 504 HP B & W Vertical Steel headers, et al.

CONDENSERS MOTOR GENERATOR SETS

Verification and proof of new equivalent condition easily reached on personal inspection

50% to 200% saving on investment

Send us list of your requirements—or what you have for sale

"Come to Cincinnati"

PAUL STEWART and COMPANY
POWER PLANT EQUIPMENT

A.C. UNITS

500 KVA. C. W.—Chuse 4 valve
450 KVA. Al.-Ch.—Hamilton Corliss
312 KVA. G.E.—Chuse 4 valve
312 KVA. G. E.—Skinner Uniflow
312 KVA. Al.-Ch.—Erie Ball 4 valve
187 KVA. G. E.—Skinner Uniflow
125 KVA. G. E.—Erie Ball 4 valve
50 KVA. G. E.—Chuse Uniflow

A.C. TURBO UNITS

1560 KVA. Wghse. "new 1921"
1250 KVA. Wghse. "Auto. bleeder"
937 KVA. G.E. "new 1924"
780 KVA. Wghse. "new 1923"
750 KVA. G. E. "bleeder"
625 KVA. Wghse. "back pressure"
375 KVA. G. E. "new 1924"
187 KVA. Wghse. "new 1924"
125 KVA. G. E. "new 1922"

Boilers (A.S.M.E.)

502 HP. Heine, 225 lbs., with Riley Underfeed Stoker, new 1926
625 HP. Erie City, Heine, new 1925, 225 lbs.
502 HP. Sterling, 200 lbs., stokers
600 HP. Heine, 200 lbs., oil burning
440 HP. Heine, 165 lbs., hand fired

POWER PLANT EQUIPMENT CO., Inc. 39-41 Cortlandt St., New York City, N. Y.

BIG BARGAIN!

185 kva. **Engine Generator Set** including exciter, generator panel, voltage regulator, etc. $900 f.o.b. cars if taken at once. 150 hp. **Ames Uniflow Engine.** Will sacrifice to move promptly.

N. F. PARENTEAU
Plaza Hotel, 551 Cass St., Milwaukee, Wis.

USED POWER EQUIPMENT

Released from service by a number of public utility companies

Electrical—Hydraulic—Mechanical

Our summary contains a complete list of equipment under above classification

WRITE TODAY FOR YOUR COPY A

Phoenix Utility Co., 2 Rector St., New York City

A.C. ENGINE Generator Set

200-Kw. Crocker Wheeler generator direct connected to Ames engine complete with switchboard, late type, in excellent condition. Immediate shipment.

Large stock of Motors, Generators, etc.

L. J. LAND
144 Grand St., New York, N. Y.

Andrew I. Mehan Co.

Dealers in New and Used Electrical Machinery
Power Plants Bought and Sold
143-145 N. 3rd St., Philadelphia, Pa.

BOILERS

2—500 HP. Heine Water Tube, 160 lbs. Pressure, A.S.M.E. code.
2—180 HP. Keeler Water Tube, 200 lb. Pressure, A.S.M.E. code.
1—150 HP. 72-in.x18-ft. Hor. Ret. Tubular, 150 lb. pressure, A.S.M.E. code.

GENERATOR SETS

2—50 Kva. 220 v., 3 ph., 60 cy. Ridgway Generators, direct connected to Ridgway Engines.

DELTA EQUIPMENT COMPANY
148 N. 3rd St. Philadelphia Pa.
Good Used Motors and Machine Tools
Write for Lists and Prices

THE O'BRIEN MACHINERY CO.
113 NORTH THIRD ST.
PHILADELPHIA, PA.

The ELECTRIC SERVICE CO. Inc.
America's Used Transformer Clearing House
212 Walnut Street Cincinnati, Ohio

TRANSFORMERS
—We buy modern type transformers—any size—any quantity.
Wanted especially—high voltage large capacity transformers in carload shipments.

POWER ENGINEERING SERVICE

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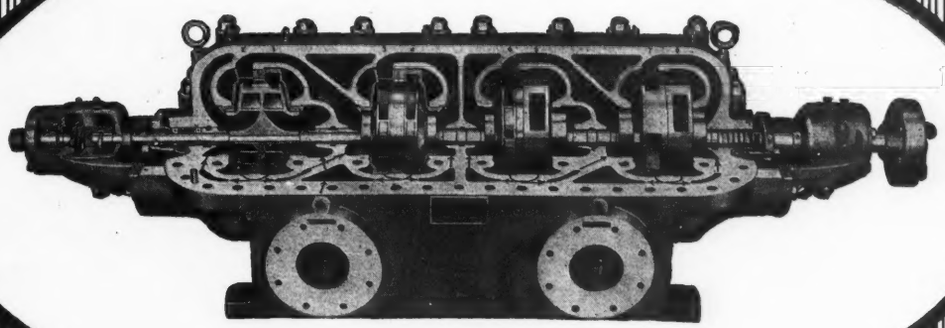

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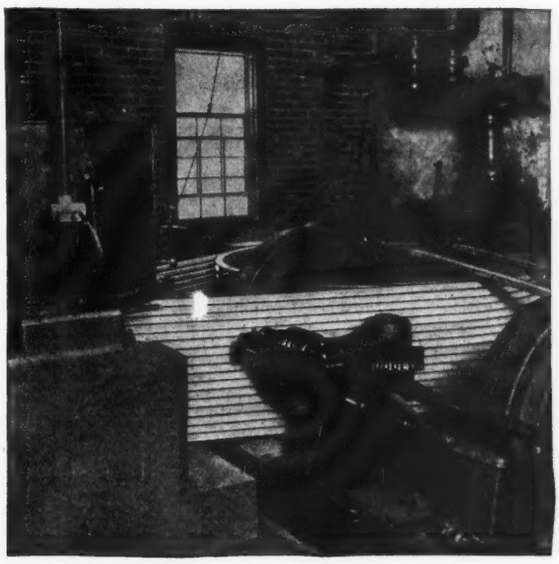

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Shaw Co., Benjamin F.

Pipe, Brass & Copper
Chase Brass & Copper Co.
Foster Wheeler Corp.

Pipe Coils
Griscom Russell Co.
Midwest Piping & Sp. Co.

Pipe Cutting & Threading Machines
Curtis & Curtis Co.
Toledo Pipe Threading Mach. Co.

Pipe Hangers & Supports
Grinnell Co.
Limbert & Co., Geo. B.
Midwest Piping & Sp. Co.
National Valve & Mfg. Co.

Pipe, Iron and Steel
Bethlehem Steel Co.
Kellogg Co., M. W.
Limbert & Co., Geo. B.
National Valve & Mfg. Co.
Reading Iron Co.
Republic Iron & Steel Co.
Shaw Co., Benjamin F.
Sprang, Chalfant & Co., Inc.

Piping Contractors
Grinnell Co.
Limbert & Co., Geo. B.
Midwest Piping & Sp. Co.
Natl. Valve & Mfg. Co.
Pittsburgh Piping & Equipment Co.
Power Piping Co.
Shaw Co., Benjamin F.

Pneumatic Tools
Ingersoll Rand Co.

Power Plant Construction
Stone & Webster, Inc.

Power Transmission Machinery
Allis-Chalmers Mfg. Co.
Dodge Mfg. Co.
Lewellan Mfg. Co.
Palmer-Bee Co.

Pre-heaters, Air
Air Preheater Corp.
Babcock & Wilcox Co.
Blaw-Knox Co.
Buffalo Forge Co.
Combustion Engr. Corp.
Edge Moor Iron Co.
Prat Daniel Corp.
Sturtevant Co., B. F.

Pulleys
Greene, Tweed & Co.
Lewellan Mfg. Co.

Pulverized Coal Equipment
Bethlehem Steel Co.
Combustion Engr. Corp.
Foster Wheeler Corp.
Fuller-Lehigh Co.
Peabody Eng. Corp.
Riley Stoker Corp.
Strong Scott Mfg. Co.

Pumps, Air Lift
Ingersoll Rand Co.
Penn. Pump & Cmprsr. Co.

Pumps, Centrifugal
Allis Chalmers Mfg. Co.
De Laval Steam Turbine Co.
Frederick Iron & Steel Co
Foster Wheeler Corp.
Gould Pumps Inc.
Kingsford Fdry. & Mch. Works
Lecourtenay Co.
Manistee Iron Works
Moore Steam Turbine Co.
Nash Engineering Co.
Penn. Pump & Cmprsr. Co.
Wheeler Mfg. Co., C. H.
Worthington Pump & Machinery Corp.

Pumps, Deep Well
Cameron Steam Pump Works, A. S.
Worthington Pump & Machinery Corp.

Pumps, Gear and Rotary
Schutte & Koerting

Pumps, Power
Gould Pumps Inc.
Worthington Pump & Machinery Corp.

Pumps, Reciprocating
Buffalo Steam Pump Co.
Gould Pumps Inc.
Platt Iron Works
Worthington Pump & Machinery Corp.

Pumps, Vacuum
Allis Chalmers Mfg. Co.
Foster Wheeler Corp.
Nash Engineering Co.
Penn. Pump & Cmprsr. Co.
Wheeler Mfg. Co., C. H.
Worthington Pump & Machinery Corp.

Purifiers, Feed Water
Cochrane Corp.
Griscom Russell Co.
Hoppes Mfg. Co.
Worthington Pump & Machinery Corp.

Purifiers, Steam
Blaw Knox Co.
Cochrane Corp.
Hagan Corp.

Pyrometers
Leeds & Northrup Co.
Republic Flow Meters Co.
Taylor Instrument Cos.

Recorders, Draft
Bailey Meter Co.
Hays Corp.
Republic Flow Meters Co.

Recorders, Gas Density
Bailey Meter Co.
General Electric Co.

Recorders, Pressure
Taylor Instrument Cos.

Recorders, Vacuum
Republic Flow Meters Co.

Refractory Placing Machines
Cement Gun Co.
Quigley Furnace Specialties Co.

Refrigerating Machinery
Vogt Mach. Co., Henry

Regulators, Damper, Draft & Fan
Atlas Valve Co.
Hagan Corp.
Leeds & Northrup Co.
Lewellan Mfg. Co.
Ruggles-Klingemann Mfg. Co.
Sarco Co.
Smoot Eng. Corp.

Regulators, Feed Water
Atlas Valve Co.
Bailey Meter Co.
Northern Equipment Co.
Ruggles-Klingemann Mfg. Co.
Squires Co., C. E.

Regulators, Gas
Davis Regulator Co.

Regulators, Pressure
Bailey Meter Co.
Chaplin Fulton Mfg. Co.
Davis Regulator Co.
Engineer Co.
Fisher Governor Co.
Northern Equipment Co.
Ruggles-Klingemann Mfg. Co.
Squires Co., C. E.
Strong, Carlisle & Hammond Co.
Taylor Instrument Cos.

Regulators, Temperature
Powers Regulator Co.
Ruggles-Klingemann Mfg. Co.
Sarco Co.
Taylor Instrument Cos.

Rheostats
Graybar Electric Co.

Rope, Transmission
American Steel & Wire Co.

Rubber Goods
Pioneer Rubber Mills

Second-Hand Equipment (See Searchlight Section)

Separators, Air, Ammonia, Oil, Steam
Cochrane Corp.
Elliott Co.
Griscom Russell Co.
Hoppes Mfg. Co.
Hagan Corp.
Marley Co.
National Valve & Mfg. Co.
Nicholson & Co., W. H.
Strong, Carlisle & Hammond Co.

Separators, Slop Oil
Condenser Service & Engineering Co.

Speed Reducers
De Laval Steam Turbine Co.
Elliott Co.
Gears & Forgings
Lewellan Mfg. Co.
Moore Steam Turbine Co.
Palmer-Bee Co.
Phila. Gear Works
Sturtevant Co., B. F.
Terry Steam Turbine Co.
Westinghouse Elec. & Mfg. Co

Spray Nozzles and Ponds
Marley Co.
Spraco, Inc.
Yarnall-Waring Co.

Stacks
Custodis Chimney Cons. Co., Alphons
Keeler Co., E.
Kellogg Co., M. W.
Prat Daniel Corp.
Rust Eng. Co.
Union Iron Works

Steel Plate Work
Union Iron Works

Stokers, Hand-Operated
Combustion Eng. Corp.
CoKal Stoker Corp.
Flynn & Emrich Co.
Kelly Foundry & Mch. Co.
McClave-Brooks Co.

Stokers, Mechanical
American Engineering Co.
Babcock & Wilcox Co.
CoKal Stoker Corp.
Combustion Eng'g Corp.
Detroit Stoker Co.
Flynn & Emrich Co.
Laclede Stoker Co.
McClave-Brooks Co.
Riley Stoker Corp.
Westinghouse Elec. & Mfg. Co.

Stops, Engine and Turbine
Gas Combustion Co.
Strong, Carlisle & Hammond Co.

Strainers, Oil, Water
Elliott Co.
Sarco Co.
Strong, Carlisle & Hammond Co.

Superheaters
Babcock & Wilcox Co.
Badenhausen Corp.
Foster-Wheeler Corp.
Marley Co.

Switchboards
General Electric Co.
Graybar Electric Co.
Westinghouse Elec. & Mfg. Co.

Switches, Electric
General Electric Co.
Westinghouse Elec. & Mfg. Co.

Tachometers
Biddle, James G.
Bailey Meter Co.
Leeds & Northrup Co.
Scherr Co., Geo.
Zernickow Co., O.

Tanks
Hercules Float Works
Union Iron Works
United Conveyors Corp.

Thermometers, Controlling, Indicating & Recording
Bailey Meter Co.
Bristol Co.
Leeds & Northrup Co.

Transformers
Allis-Chalmers Mfg. Co.
Graybar Electric Co.

Traps, Air, Grease, Non Return, Return, Radiator, Steam, Vacuum
Armstrong Machine Works
Davis Regulator Co.
Ellis Drier Co.
Elliott Co.
Fisher Governor Co.
Jenkins Bros.
Morehead Mfg. Co.
Nason Mfg. Co.
Nicholson & Co., W. H.
Powers Regulator Co.
Reliance Gauge Column Co.
Sarco Co.
Squires Co., C. E.
Strong, Carlisle & Hammond Co.
Williams Gauge Co.

Tube Cleaners, Boiler
Chesterton Co., A. W.
Ge[illegible] Specialty Co.
La[illegible] Mfg. Co.
Liberty Mfg. Co.
Roto Co.

Tube Cleaners, Condenser
Garlock Packing Co.
Lagonda Mfg. Co.
Liberty Mfg. Co.
Roto Co.

Tube Cutters
Lagonda Mfg. Co.

Tubes, Boiler
Bethlehem Steel Co.
Boiler Tube Co. of Am.
Reading Iron Co.
Tyler Tube & Pipe Co.

Tubes, Condenser
Boiler Tube Co. of Am.
Chase Brass & Copper Co.

Tubing
Boiler Tube Co. of Amer.
Chase Brass & Copper Co.

Turbines, Steam
Allis Chalmers Mfg. Co.
De Laval Steam Turbine Co.
Elliott Co.
General Electric Co.
Moore Steam Turbine Co
Sturtevant Co., B. F.
Terry Steam Turbine Co.
Westinghouse Elec. & Mfg. Co.

Turbines, Water
Allis Chalmers Mfg. Co.
Morris & De La Vergne I. P.

Vacuum Cleaners
Allen & Billmyre Co.
Sturtevant Co., B. F.

Valve Disks
Garlock Packing Co.
Jenkins Bros.

Valve Reseating Machine
Leavitt Mach. Co.

Valves, Ammonia
Strong, Carlisle & Hammond Co.
Vogt Mach. Co., Henry

Valves, Automatic Air
Crane Co.
Simplex Valve & Mtr. Co.
Strong, Carlisle & Hammond Co.

Valves, Automatic Cutoff
Elliott Co.
Strong, Carlisle & Hammond Co.

Valves, Back Pressure
Davis Regulator Co.
Jenkins Bros.

Valves, Blowoff
Chapman Valve Mfg. Co.
Elliott Co.
Jenkins Bros.
Multi Valve Co.
Strong, Carlisle & Hammond Co.
Yarnall-Waring Co.

Valves, Brass & Iron Body
Chapman Valve Mfg. Co.
Jenkins Bros.
Pittsburgh Piping & Equipment Co.
Strong, Carlisle & Hammond Co.

Valves, Check and Stop
Chapman Valve Mfg. Co.
Davis Regulator Co.
Elliott Co.
Greene Tweed & Co.
Kennedy Valve Mfg. Co.
Strong, Carlisle & Hammond Co.
Schutte & Koerting
Strong, Carlisle & Hammond Co.
Williams Gauge Co.

Valves, Electrically Operated
Chapman Valve Mfg. Co.
Crane Co.
Strong, Carlisle & Hammond Co.

Valves, Float
Davis Regulator Co.
Northern Equipment Co.

Valves, Plug
Chapman Valve Mfg. Co.
Kennedy Valve Mfg. Co.
Nicholson & Co., W. H.
Vogt Mach. Co., Henry

Valves, Pump
Garlock Packing Co.
Jenkins Bros.
Williams Gauge Co.

Valves, Reducing
Atlas Valve Co.
Bailey Meter Co.
Fisher Governor Co.
Northern Equipment Co.
Squires Co., C. E.
Strong, Carlisle & Hammond Co.

Valves, Regulating
Atlas Valve Co.
Bailey Meter Co.
Multi Valve Co.
Northern Equipment Co.
Sarco Co.
Schutte & Koerting
Simplex Valve & Mtr. Co.
Squires Co., C. E.
Strong, Carlisle & Hammond Co.

Valves, Relief
Northern Equipment Co.
Strong, Carlisle & Hammond Co.

Valves, Safety
Jenkins Bros.

Valves, Throttle
Strong, Carlisle & Hammond Co.

Valves, Two, Three, Four Way
Nicholson & Co., W. H.

Ventilators
Burt Mfg. Co.

Vessels, Pressure
Babcock & Wilcox Co.

Vises
Toledo Pipe Threading Mach. Co.

Walls, Water
American Engineering Co.
Badenhausen Corp.
Blaw Knox Co.
Edgemoor Iron Co.
Fuller-Lehigh Co.
Riley Stoker Corp.

Waterbacks, High & Low Pressure
Foster Wheeler Corp.
McClave-Brooks Co.

Water Columns
Diamond Power Specialty Corp.
Reliance Gauge Column Co.
Williams Gauge Co.
Yarnall-Waring Co.

Water Testing Equipment
Elgin Softener Co.

Water Treating Chemicals
Dearborn Chemical Co.
Garratt, Callahan Co.
Victor Chemical Works

Water Treating Equipment
Cochrane Corp.
Dearborn Chemical Co.
Hagan Corp.
Inversand Co.
Scaife & Sons Co., Wm. B.

Welders
Lincoln Electric Co.

Water Wheels
Allis Chalmers Mfg. Co.

Whistles
Lunkenheimer Co.

Wire, Electric
American Steel & Wire Co.
Graybar Electric Co.

Wire & Rods, Welding
American Steel & Wire Co.
Lincoln Electric Co.

Wrenches
Greene Tweed & Co.

Zeolites
Inversand Co.

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5. Greater Overload Capacity

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The improvements are plentiful as pins in a new shirt."

PROGRESS

THE LINCOLN ELECTRIC COMPANY
Department No. 2-6 CLEVELAND, OHIO

M-69

LINCOLN
"LINC-WELD" MOTORS

Alphabetical Index to Advertisements

This index is published as a convenience to the reader. POWER assumes no responsibility for errors or omission. Where an * appears after a name the advertisement does not appear in this issue, but appeared in preceding issues.

	Page
Air Preheater Corp.	60
Alberger Heater Co.	60
Allen & Billmyre Co.	68
Allen-Sherman-Hoff Co.	70
Allis-Chalmers Mfg. Co.	103
American Brass Co.	*
American District Steam Co.	80
American Engineering Co.	64
American Hoist & Derrick Co.	*
American Pulverizer Co.	92
American Radiator Co.	*
American Steam Pump Co.	*
American Steel & Wire Co.	44
Anderson Co., V. D.	*
Anderson Engine & Fdry. Co.	*
Armstrong Machine Works	86
Ashton Valve Co.	*
Atlas Valve Co.	84
Babcock & Wilcox Co.	50, 68
Babcock & Wilcox Tube Co.	*
Badenhausen Corp.	96
Badger & Sons Co., E. B.	77
Bailey Meter Co.	7
Bartlett Hayward Co.	*
Bartlett Tree Expert Co.	*
Bartlett & Snow Co., C. O.	*
Belmont Packing & Rubber Co.	*
Bernitz Furnace Appliance Co.	69
Bethlehem Steel Co.	71
Betson Plastic Fire Brick Co.	21
Biddle, James G.	88
Bigelow-Liptak Corp.	68
Blaw-Knox Co.	9
Boiler Engineering Co.	62
Boiler Tube Co. of America	54
Borne Scrymser Co.	*
Bowker Chemical Co.	*
Bristol Co.	90
Brown Instrument Co.	*
Buffalo Forge Co.	60
Buffalo Steam Pump Co.	74
Burke Electric Co.	*
Burt Mfg. Co.	94
Builders Iron Foundry Co.	*
Byron Jackson Co.	*
Caldwell Co., W. E.	*
Carborundum Co.	65
Carey Co., Philip.	Front Cover
Cement-Gun Co.	97
Centrifix Corp.	*
Century Electric Co.	*
Chain Belt Co.	*
Chaplin-Fulton Mfg. Co.	92
Chapman Valve Mfg. Co.	28-29
Chase Brass & Copper Co.	72
Cheesman-Elliot Co.	*
Chesterton Co., A. W.	52
Chicago Pneumatic Tool Co.	*
Clarage Fan Co.	61
Clements Mfg. Co.	*
Cleveland Worm & Gear Co.	*
Cochrane Corp.	41
Coen Co.	56
CoKal Stoker Corp.	64
Colt's Patent Fire Arms Mfg. Co.	*
Combustion Engineering Corp.	15
Commercial Credit Co.'s	33
Condenser Service & Engineering Co.	70
Connelly Boiler Co., D.	48
Connery & Co.	*
Consolidated Ashcroft Hancock Co.	*
Coppus Engrg. Corp.	*
Crane Co.	26-27
Crane Packing Co.	*
Crocker-Wheeler Electric Mfg. Co.	*
Crosby Steam Gage & Valve Co.	*
Curtis & Curtis Co.	74
Custodis Chimney Construction Co., Alphons	66
Cutler-Hammer, Inc.	*
Dampney Co. of America	56
Dart Mfg. Co., E. M.	74
Davis Regulator Co.,	Fourth Cover
Dearborn Chemical Co.	88
Deep Rock Oil Corp.	90
DeLaval Separator Co.	*
DeLaval Steam Turbine Co.	48
Denver Fire Clay Co.	*
d'Este Co., Julian	*
Detrick Co., M. H.	67
Detroit Stoker Co.	64
DeWolf Furnace Corp.	68
Diamond Power Specialty Corp.	97
Direct Separator Co.	*
Directory of Engineering	100
Dixon Crucible Co., Jos.	87
Dodge Mfg. Corp.	97
Dravo-Doyle Co.	90
Edge Moor Iron Co.	50
Edward Valve & Mfg. Co.	*
Electric Machinery Mfg. Co.	53
Elgin Softener Corp.	56
Elliott Co.	Third Cover, 82
Ellis Drier Works	88
Ellison Draft Gage Co.	*
Engineer Co.	64
Evans Elevator Equalizer Co.	*
Fairbanks, Morse & Co.	*
Falk Corp.	*
Ferodo & Asbestos	*
Filtrators Co.	*
Fisher Governor Co.	83
Flexitalic Gasket Co.	94
Flynn & Emrich Co.	64
Foster Wheeler Corp.	12-13
Foxboro Co.	*
France Packing Co.	97
Frederick Iron & Steel Co.	74
Fuller Lehigh Co.	23
Fulton Iron Works Co.	*
Fulton Syphon Co.	*
Gardner-Denver Co.	*
Garlock Packing Co.	20
Garratt-Callahan Co.	56
Gas Combustion Co.	48
Gears & Forgings	38
General Electric Co.	2, 57-58
General Insulating & Mfg. Co.	*
General Refractories Co.	68
General Specialty Co.	54
Golden Anderson Valve Specialty Co.	*
Goodyear Tire & Rubber Co.	*
Goulds Pumps	72
Graybar Electric Co.	73
Green Fire Brick Co., A. P.	*
Green Fuel Economizer Co.	60
Greene, Tweed & Co.,	Fourth Cover
Grinnell Co.	18-19
Griscom-Russell Co.	37
Hagan Corp.	62
Hammel Oil Burning Equipment Co.	64
Harbison-Walker Refractories Co.	68
Hawk-Eye Compound Co.	*
Hays Corp.	88
Hendrick Mfg. Co.	*
Henszey De Concentrator Co.	56
Hercules Float Works	74
Holmes Metallic Packing Co.	*
Homestead Valve Mfg. Co.	*
Hoppes Mfg. Co.	60
Houghton & Co., E. F.	*
Howard Iron Works	60
Huyette Co., Paul B.	56
Ideal Commutator Dresser Co.	*
Illinois Stoker Co.	66
Industrial Brownhoist Corp.	72
Ingersoll-Rand Co.	14
International Combustion Engineering Corp.	15
International Filter Co.	*
International Nickel Co.	*
Inversand Co.	56
I-T-E- Circuit Breaker Co.	*
Jefferson Union Co.	*
Jeffrey Mfg. Co.	*
Jenkins Bros.	4
Johns-Manville Corp.	*
Johnston & Jennings Co.	*
Keasbey & Mattison Co.	*
Keating Pipe Bending & Supply Co., E. F.	*
Keeler Co., E.	52
Kellogg Co., M. W.	78
Kelly Fdry. & Machine Co.	62
Kennedy-VanSaun Mfg. & Eng. Corp.	*
Kennedy Valve Mfg. Co.	84
Key Boiler Equipment Co.	*
Keystone Refractories Co.	70
King Refractories Co.	17
Kingsford Fdry. & Machine Works	52
Kopperman & Sons, Jos.	*
Laclede-Christy	68
Laclede Stoker Co.	66
Lagonda Mfg. Co.	54
Lavino & Co., E. J.	68
Leavitt Machine Co.	84
Lecourtenay Co.	74
Leeds & Northrup Co.,	Second Cover
Lewellen Mfg. Co.	97
Liberty Mfg. Co.	54
Limbert & Co., Geo. B.	81
Lincoln Electric Co.	105
Link-Belt Co.	*
Lonergan Co., J. E.	*
Lunkenheimer Co.	*
Manistee Iron Works Co.	101
Manzel Bros.	*
Marley Company	70
Mason Regulator Co.	*
McClave Brooks Co.	62
McGowan Co., John H.	*
McGraw-Hill Book Co.	64, 82
McIntosh & Seymour Corp.	*
McKenzie Arch Co.	*
McLeod & Henry Co.	66
Meriam Co.	*
Merrill & Co., Wm. B.	*
Metallo Gasket Co.	94
Midwest Piping & Supply Co.	24-25
Modine Mfg. Co.	*
Moore Steam Turbine Corp.	48
Morehead Mfg. Co.	84
Morris & DeLa Vergne, I. P.	49
Morse Chain Co.	*
Multi-Valve Corp.	36
Nash Engineering Co.	74
Nason Mfg. Co.	88
National Airoil Burner Co.	63
National Aluminate Corp.	*
National Flue Cleaner Co.	*
National Tube Co.	*
National Valve & Mfg. Co.	75
Neckar Water Softener Corp.	*
Neemes Foundry	62
Nicholson & Co., W. H.	86
Nordberg Mfg. Co.	*
North American Refractories Co.	68
Northern Equipment Co.	5
Norton Co.	*
Nugent & Co., Wm. W.	90
Oakite Products	52
Obermayer Co., S.	*
Oster Mfg. Co.	*
Otis Elevator Co.	*
Page Contracting Co., Fredk.	*
Palmer-Bee Co.	92
Peabody Engineering Corp.	64
Peale, Peacock & Kerr	*
Penberthy Injector Co.	43
Pennsylvania Pump & Compressor Co.	46
Permutit Co.	*
Philadelphia Gear Works	94
Pierce Co., Wm. B.	*
Pioneer Rubber Mills	94
Pittsburgh Piping & Equipment Co.	74
Pittsburgh Steel Products Co.	*
Pittsburgh Valve Fdry. & Const. Co.	*
Platt Iron Works	74
Plibrico Jointless Firebrick Co.	*
Powell Co., Wm.	*
Power Piping Co.	*
Power Turbo Blower Co.	*
Powers Regulator Co.	88
Prat-Daniel Corp.	60
Pure Oil Co.	93
Quigley Furnace Specialties Co.	66
Reading Iron Co.	79
Reading Steel Casting Co.	*
Reeves Pulley Co.	*
Reliance Gauge Column Co.	3
Republic Flow Meters Co.	10-11
Republic Steel Corp.	32
Rhoads & Sons, J. E.	*
Richardson Scale Co.	*
Ric-Wil Co.	*
Riley Stoker Corp.	34-35
Robins Conveying Belt Co.	*
Rockwell Co., W. S.	*
Ross Heater Mfg. Co.	*
Roto Company	54
Ruggles-Klingemann Mfg. Co.	84
Rust Engineering Co.	48
Ruths Steam Storage	*
Sarco Company	84
Sauerman Bros.	70
Scaife & Sons Co., Wm. B.	56
Scherr & Co., Geo.	88
Schutte & Koerting Co.	72
Scovill Mfg. Co.	*
Searchlight Section (See Alphabetical Index listed below)	98-99
Seymour, Jas. M.	70
Shaw Co., Benj., F.	22
Shaw-Kendall Engrg. Co.	*
Shell Petroleum Corp.	*
Simplex Valve & Meter Co.	92
Skinner Engine Co.	47
Smith Corp., A. O.	*
Smith & Serrell	*
Smoot Engineering Corp.	59
Smooth-On Mfg. Co.	39
Spang, Chalfant & Co.	31
Speer Carbon Co.	*
Sparco	95
Springfield Boiler Co.	52
Squires Co., C. E.	86
Standard Oil Co. (Indiana)	91
Standard Power Equip. Corp.	*
Standard Wire & Tube Co.	92
Sterling Engine Co.	48
Sterling Engrg. & Mfg. Corp.	86
Stockham Pipe & Fittings Co.	30
Stone & Webster Engineering Corp.	40
Stratton Engineering Corp.	55
Strong, Carlisle & Hammond Co.	85
Strong-Scott Mfg. Co.	70
Sturtevant Co., B. F.	8
Sullivan Machinery Co.	51
Superheater Co.	*
Swann Chemical Co.	*
Taylor Instrument Co.'s	86
Taylor Forge & Pipe Works	*
Templeton Mfg. Co.	86
Terry Steam Turbine Co.	45
Texas Company	89
Thomas Grate Bar Co.	*
Timken Roller Bearing Co.	*
Toledo Pipe Threading Machine Co.	72
Tri-Lok Co.	90
Troy Engine & Machine Co.	*
Tube-Turns	*
Tyler Tube & Pipe Co.	54
Union Carbide and Carbon Corp.	76
Union Iron Works	50
Union Steam Pump Co.	*
United Conveyor Corp.	70
United States Graphite Co.	90
Vacuum Oil Co.	*
Vilter Mfg. Co.	*
Vogt Machine Co., Henry	56
Vulcan Soot Cleaner Co.	54
Wailes-Dove-Hermiston Corp.	52
Warren Steam Pump Co.	*
Watson & McDaniel Co.	*
Watts Regulator Co.	*
Webster & Co., Warren	*
Westfalia Separator Co.	*
Westinghouse Electric & Mfg. Co.	6
Weston Electrical Instrument Corp.	*
Wheeler Mfg. Co., C. H.	70
Whiting Corp.	*
Whiton Machine Co., D. E.	*
Wickes Boiler Co.	50
Williams Gauge Co.	84
Wing Co., L. J.	60
Worthington Pump & Machinery Corp.	16
Wright-Austin Co.	*
Yarnall-Warring Co.	Insert between pages 16 and 17, 70
York Heating & Ventilating Corp.	*
Zenon, Yvan	90
Zernickow Co., O.	88

Searchlight Section

Classified Advertising

PATENT ATTORNEY	98
POSITIONS VACANT	98
POSITIONS WANTED	98
SALESMEN AVAILABLE	98
REPRESENTATIVES WANTED	98
USED EQUIPMENT	98-99
Crawbuck Co., John D.	98
Delta Equipment Co.	99
Electric Service Co., Inc., The	99
Elliott Co.	98
Hackett, W. H.	98
Land, L. J.	99
Mehan Co., Andrew I.	99
O'Brien Mchy. Co.	99
Parenteau, N. F.	99
Phoenix Utility Co.	99
Power Plant Equipment Co.	99
Sachsenmaier, Geo.	99
Stewart & Co., Paul	99